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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr' a
10^{9}	giga	G	jĭ' ga
10^{6}	mega	M	mĕg' a
10^{3}	kilo	k	kĭl' o
10^{2}	hecto	h	hĕk' to
10	deka	da	dĕk' a
10^{-1}	deci	d	dĕs' i
10^{-2}	centi	c	sĕn' ti
10^{-3}	milli	m	mĭl' i
10^{-6}	micro	μ	mi' kro
10^{-9}	nano	n	năn' o
10^{-12}	pico	p	pē' co
10^{-15}	femto	f	fĕm' to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps
cm	centimeter(s)	0.394 inch
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	
GeV	giga electron volts	1.6×10^{-3} ergs
kg	kilogram(s)	1,000 g=2.205 lb
km^2	square kilometer(s)	
kVp	kilovolt peak	
m^3	cubic meter(s)	
mA	milliampere(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
MeV	million (mega) electron volts	1.6×10^{-6} ergs
mg	milligram(s)	
mi^2	square mile(s)	
ml	milliliter(s)	
mm	millimeter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
pCi	picocurie(s)	10^{-12} curie = 2.22 dpm
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g

RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 8, Number 11, November 1967

In August 1959, the President directed the Secretary of Health, Education, and Welfare, to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial uses of isotopes and X rays, and fallout. The Department delegated this responsibility to the National Center for Radiological Health, Public Health Service.

Radiological Health Data and Reports, a monthly publication of the Public Health Service, includes data and reports provided to the National Center for Radiological Health by Federal agencies, State health departments, universities, and foreign governmental agencies. Pertinent original data and interpretive manuscripts are invited from investigators.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service ● National Center for Radiological Health

Reports

State Health Department Sampling Criteria for Surveillance of Radioactivity in Milk

R. H. Neill and *D. R. Snavely* [1]

This report summarizes criteria used by the States in setting up their milk sampling programs for measurement of radioactivity and the sample typing, collection points, and measurements used. Also included are the times required by the States from sample collection to the final radioactivity concentrations of the various radioisotopes found in milk.

Sampling criteria and related data concerning surveillance programs operated by State health agencies for radioactivity in milk are summarized in this report. The information is primarily based on survey results secured during the last quarter of 1965 from State radiological health program personnel.

Earlier reports have been published concerning agencies known to have been actively conducting milk surveillance in 1960 (*1*) and on general details of State surveillance programs for radioactivity in milk as they had developed by 1963 (*2*). The 1965 survey was directed toward determining to what extent there are common denominators or differences in sampling criteria employed among the State programs. The survey was considered a necessary first step in inventorying the potential for mutual support among State and Federal environmental radiation control programs.

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Survey procedure

State health department officials involved with radiological health programs were requested to supply detailed information under the following survey form categories: (1) basis for selecting milk sampling locations, (2) sampling procedures for raw and/or pasteurized milk, (3) average time from the date of sample collection, under both routine and emergency conditions, for analytical results to be made available, and (4) proposed plans for modifying routine and emergency milk surveillance networks in the near future. Of the 39 States operating some type of milk surveillance program, responses were received from 38. Therefore, the following tables are based on these 38 States. The results were summarized by common criteria under each of the four categories.

Operational status of State milk surveillance programs

The increased State participation in milk surveillance programs is illustrated in figure 1. By October 1965, 39 States had some type of surveillance program for radioactivity in milk.

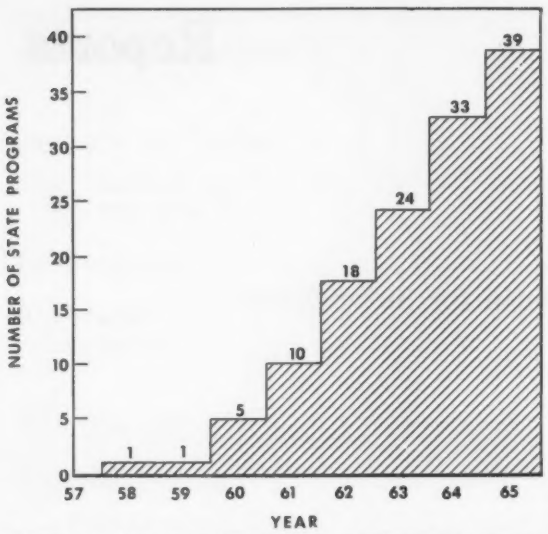

Figure 1. Number of State milk surveillance programs by year

The operational status of these programs may be classified into the following three groups and are shown in figure 2:

1. ACTIVE: Both sampling and analysis capabilities exist and are operating.
2. LIMITED ACTIVE: Sampling is performed by the State, but analysis is performed by a non-State agency.
3. INACTIVE: Networks are presently inoperative, but both sampling and analysis have been previously conducted and can be reactivated.

Basis for selecting State milk sampling locations

Four bases for selecting milk sampling locations were identified and listed on the survey form. These were geography, population, milk production and/or processing, and nuclear facilities. A fifth category of "other" was also included. Thirty-one States used one or two of these bases. A summary of sampling location bases for these 31 States appears below in table 1 and includes States with all three degrees of operational status. Those States sampling raw or pasteurized milk or both are also listed in table 1. The individual numbers appearing in each box indicate the number of

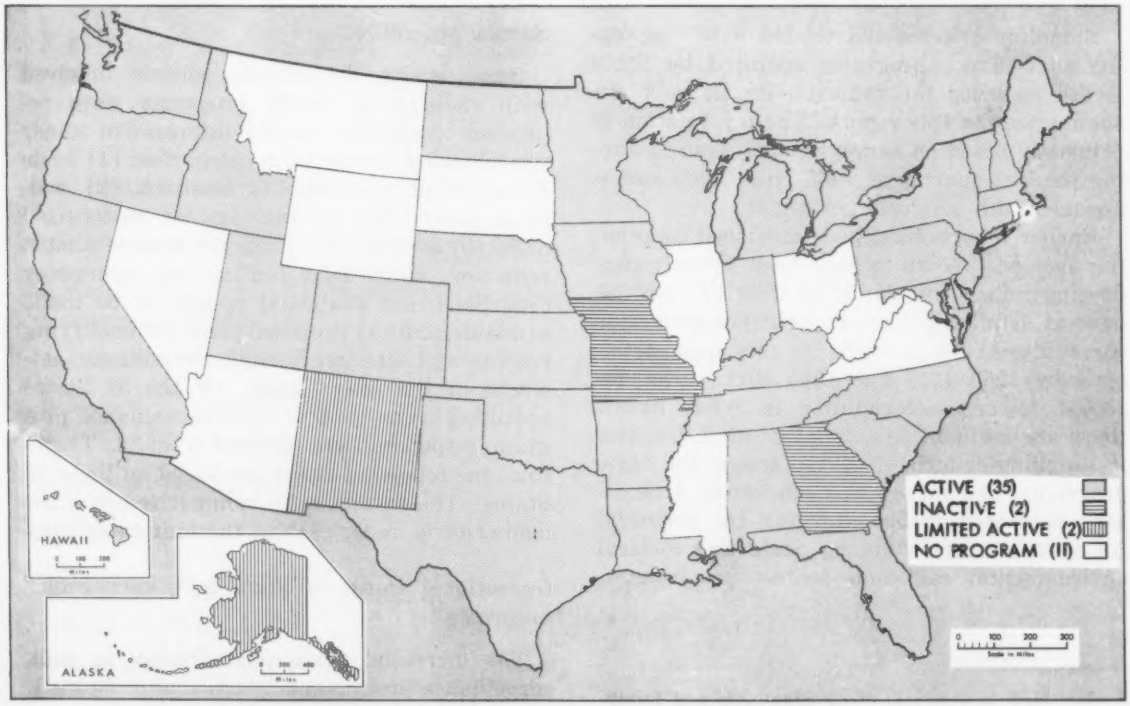

Figure 2. Operational status of State milk surveillance program
October 1965

States that selected the applicable sampling location bases under raw or pasteurized milk or both. An explanation of table 1 follows:

	Type of milk	Population (b)
Geography (a)	Raw only	1
	Pasteurized only	1
	Both	0

The criteria "Geography" and "Population" were used to establish sampling networks by one State that sampled only raw milk, one State that only sampled pasteurized milk and there were not any States that sampled both types of milk. Therefore, two States used both (a) and (b) criteria.

As observed in table 1, four of the six States sampling only raw milk indicated considerations of "geography," singly and in combinations, as the predominant basis for selecting their sampling locations. Among the 15 States with only pasteurized milk sampling programs, the basis of "production and processing" figured in the sampling plans of 10 of them, with "geography" ranking as the next most common basis in seven State programs. The basis of "population" figured in only two of the six raw milk sampling programs and in only three of the fifteen pasteurized milk sampling programs.

Three States were found to use a combination of three sampling location bases—geography, population, and production and processing. Two States indicated four bases were considered in selecting sampling locations and one State reported using all four plus the category of "other." Table 2 summarizes the sampling location bases used by the seven States where three or more bases were involved.

Table 2. Type of milk sampled by States using more than two bases to determine sampling location

Sampling code [a]	Raw milk only	Pasteurized milk only	Both
(a), (b), (c)	1	1	1
(a), (b), (c), (d)	0	1	1
(a), (b), (c), (e)	1	0	0
(a), (b), (c), (d), (e)	0	1	0

[a] See table 1 for sampling basis identification.

Sampling procedures for raw and pasteurized milk sample collection points

Once a decision has been made regarding a basis (or bases) for locating stations in a milk sampling network, a closely related consideration involves selecting a specific link in the milk production, processing and distribution chain at which samples will be collected. These links or points at which milk samples are collected

Table 1. Number of States using one or two bases for selecting milk sampling locations

Basis for selecting milk sampling location	Code	Type of milk	Geography (a)	Population (b)	Production and processing (c)	Nuclear facilities (d)	Other (e)	Total
Geography	(a)	Raw only	2	1	0	0	1	4
		Pasteurized only	2	1	3	0	1	7
		Both	3	0	1	2	0	6
Population	(b)	Raw only		1	0	0	0	1
		Pasteurized only		0	2	0	0	2
		Both		0	0	0	0	0
Production and processing	(c)	Raw only			0	0	0	0
		Pasteurized only			5	0	0	5
		Both			2	1	1	4
Nuclear facilities	(d)	Raw only				1	0	1
		Pasteurized only				0	1	1
		Both				0	0	0
Other	(e)	Raw only					0	0
		Pasteurized only					0	0
		Both					0	0
Total		Raw only						6
		Pasteurized only						15
		Both						10

will vary depending on the type of milk sampled. Information on the location of the collection sites of the State milk programs was also obtained and is summarized on figure 3.

Table 3 summarizes sample collection points for the 16 State raw and raw plus pasteurized milk sampling locations. "Farm" and "farm and storage tank" responses for sampling points were combined; "storage tank" responses were maintained separately as these can be associated with raw milk as well as with pasteurized milk sampling programs. It can be observed that twice as many "farm" sample collection points as "tank truck" sample collection points were reported. Table 4 displays similar information for those raw milk and raw plus pasteurized milk sampling programs which utilized three or more bases for determining sampling locations.

Table 5 lists those sample collection points for pasteurized milk and for pasteurized plus raw milk sampling programs stratified by one or two bases for determining sampling locations. The majority of sample collection points falls under the headings of "plant" and "plant and retail outlet." The overlap in numbers of State programs between table 5 and table 3 should be noted. This is explained by the ten States which reported sampling both raw and pasteurized milk. Similarly, table 6 illustrates the pattern of sample collection points utilized by pasteurized milk, and pasteurized and raw milk sampling programs where three or more bases for establishing sampling locations were used.

Table 3. Sample collection points for raw and raw plus pasteurized milk sampling programs [a]

Basic for selecting milk sampling location	Code	Sample collected from:	Number of States selecting criteria					
			Geography (a)	Population (b)	Production and processing (c)	Nuclear facilities (d)	Other (e)	Total
Geography	(a)	Farm and/or farm storage tank	3	0	0	2	1	6
		Tank truck	1	1	1	0	0	3
		Storage tank [b]	1	0	0	0	0	1
Population	(b)	Farm and/or farm storage tank		0	0	0	0	0
		Tank truck		1	0	0	0	1
		Storage tank		0	0	0	0	0
Production and processing	(c)	Farm and/or farm storage tank			1	1	0	2
		Tank truck			0	0	0	0
		Storage tank			1	0	1	2
Nuclear facilities	(d)	Farm and/or farm storage tank				1	0	1
		Tank truck				0	0	0
		Storage tank				0	0	0
Other	(e)	Farm and/or farm storage tank					0	0
		Tank truck					0	0
		Storage tank					0	0
Total		Farm and/or farm storage tank						9
		Tank truck						4
		Storage tank						3

[a] Limited to State programs stratified by 1 or 2 bases for determining sampling locations.
[b] See text.

Table 4. Sample collection points for raw and raw plus pasteurized milk sampling programs [a]

Sampling code [b]	Farm and/or farm storage tank	Tank truck	Storage tank
(a), (b), (c)	0	1	1
(a), (b), (c), (d)	1	0	0
(a), (b), (c), (e)	1	0	0
(a), (b), (c), (d), (e)	0	0	0

[a] Limited to State programs stratified by three or more bases for determining sampling locations.
[b] See table 3 for sampling bases identification.

Sampling frequencies and compositing practices

Of the 38 States responding to the questionnaire at the time the survey was carried out, five States sampled on at least a daily basis, 14 States had weekly programs, another 14 States sampled on at least a monthly basis and 5 States had quarterly surveillance programs.

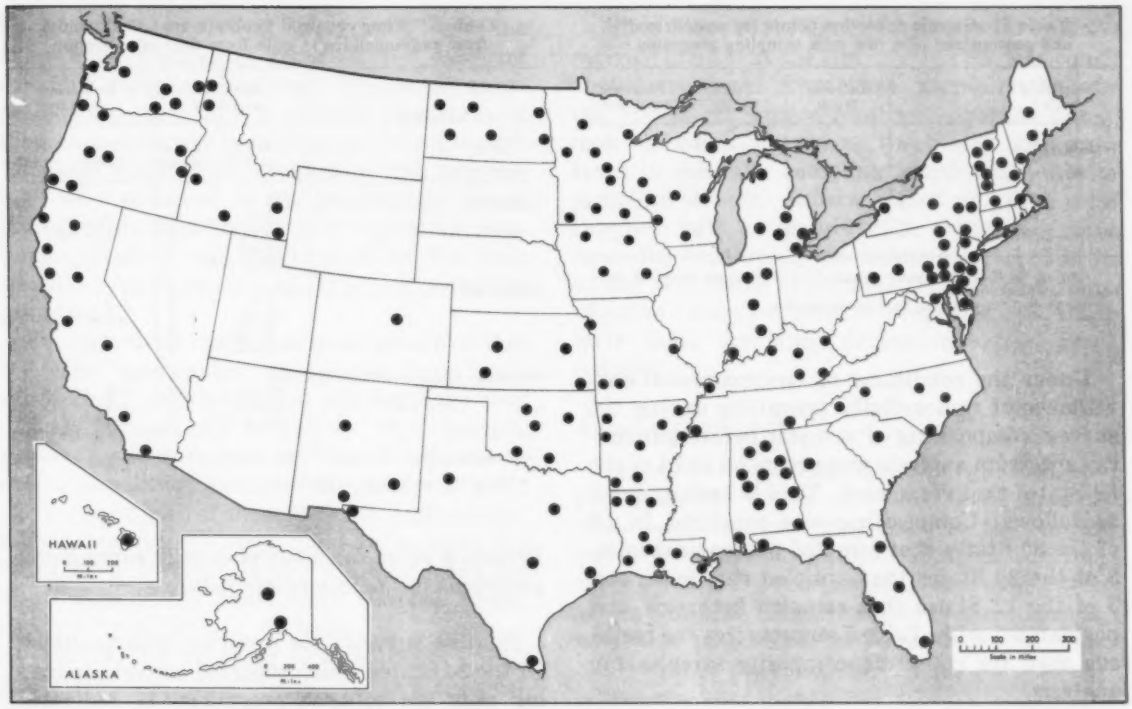

Figure 3. Sample collection sites of State milk programs October 1965

Table 5. Sample collection points for pasteurized and pasteurized plus raw milk sampling programs [a]

Basis for selecting milk sampling location	Code	Sample collected from:	Number of States selecting criteria					
			Geography (a)	Population (b)	Production and processing (c)	Nuclear facilities (d)	Other (e)	Total
Geography	(a)	Plant	2	1	2	0	0	5
		Delivery truck	0	0	1	0	0	1
		Retail outlet	1	0	0	1	0	2
		Plant & retail outlet	2	0	1	1	1	5
Population	(b)	Plant		0	1	0	0	1
		Delivery truck		0	0	0	0	0
		Retail outlet		0	1	0	0	1
		Plant & retail outlet		0	0	0	0	0
Production and processing	(c)	Plant			5	0	1	6
		Delivery truck			1	0	0	1
		Retail outlet			1	0	0	1
		Plant & retail outlet			0	1	0	1
Nuclear facilities	(d)	Plant				0	0	0
		Delivery truck				0	1	1
		Retail outlet				0	0	0
		Plant & retail outlet				0	0	0
Other	(e)	Plant					0	0
		Delivery truck					0	0
		Retail outlet					0	0
		Plant & retail outlet					0	0
Total		Plant						12
		Delivery truck						3
		Retail outlet						4
		Plant & retail outlet						6

[a] Limited to State programs stratified by 1 or 2 bases for determining sampling locations.

Table 6. Sample collection points for pasteurized and pasteurized plus raw milk sampling programs [a]

Sampling basis [b]	Plant	Delivery truck	Retail outlet	Plant and retail outlet
(a), (b), (c)	1	0	1	0
(a), (b), (c), (d)	1	0	0	1
(a), (b), (c), (e)	0	0	0	0
(a),(b),(c),(d),(e)	0	0	0	1

[a] Limited to State programs stratified by 3 or more bases for determining sampling locations.
[b] See table 5 for sampling bases identification.

Under the conditions of environmental surveillance of radioactivity prevailing during the survey, compositing of samples before gamma-ray spectrum analysis was practiced in 18 of the 38 States that responded. This is broken down as follows: Compositing was practiced in 13 of the 30 States that sampled pasteurized milk, 8 of the 20 States that sampled raw milk, and 3 of the 12 States that sampled both raw and pasteurized milk. Table 7 summarizes the methods used for collecting composite samples for analysis.

Table 7. Method of compositing milk samples

Method	No. of States sampling pasteurized milk	No. of States sampling raw milk
By equal subsample volumes	7	5
By subsample volumes proportional to milk production or consumption represented by subsample	4	2
By subsample volumes proportional to time interval represented by subsample	2	1

Average time periods for obtaining analytical results

The average time between collection of milk samples and obtaining analytical results is one measure of the efficiency of a sampling program, particularly with respect to reducing the dose from iodine–131 to the milk drinking population through protective action. Table 8 summarizes the periods of time required to obtain analytical results for four radionuclides under routine and emergency conditions.

Table 8. Time required to obtain analytical results from radionuclides in milk from date of collection

Nuclide	Routine conditions		Emergency conditions	
	Time (days)	No. of States	Time (days)	No. of States
Iodine-131	< 3	18	<1	12
	3–7	10	1–3	19
	8–14	3	NS or NA	7
	15–30	3		
	NS or NA [a]	4		
Cesium-137	< 3	16	<1	10
	3–7	9	1–3	17
	8–14	2	NS or NA	11
	15–30	3		
	NS or NA	8		
Strontium-89 and strontium-90	<15	9	<1	1
	15–30	17	1–3	11
	31–120	5	4–7	5
	NS or NA	7	8–30	11
			NS or NA	10

[a] NS or NA, no sample or analysis.

Proposed plans for modifying milk surveillance programs in the immediate future

Routine surveillance program modifications: Of the 34 States which reported actively operating milk surveillance programs, 17 indicated no immediate changes were contemplated in their present method of surveillance. One State intended to decrease its sampling program, and five States planned to expand their programs, either by increasing the number of sampling locations or by improving their radioanalytical capabilities.

Emergency surveillance program modifications: Seven States indicated that no changes were planned. Two States were developing plans for using ion exchange cartridges for iodine–131 determinations. One State indicated intentions of establishing a new laboratory nearer to an important potential source for the release of fission products and another State had plans to expand its basic data on milk sampling locations.

Discussion and summary

No attempt was made in the survey forms to define a single basis for reporting how milk sampling locations were selected. Instead, latitude was given the survey respondents to report more than one basis if that were the case.

The results showed that "geography" was the basis most frequently reported for selecting raw milk sampling locations. This is not unexpected since raw milk is sampled at a farm or farms—a geographical criterion. "Geography" combined with "milk production and processing" were observed as the predominant bases for selecting pasteurized milk sampling locations. "Population" appeared to be the least employed basis among all types of sampling programs.

For pasteurized milk, one must recognize that the terms "geography," "population," and "milk processing" (pasteurization and bottling) may not all be mutually exclusive. For example, processing centers may be located adjacent to major population centers. Respondents could check one or both of these criteria. Additionally, milk sampling locations could be selected for cities of a certain size in different counties. Here respondents could have checked "geography," "population," or both.

"Farms and/or farm storage tanks" were preferred over "tank trucks" for raw milk collection points. Among the pasteurized milk sampling programs, a preference was observed for "milk processing plants" over "retail outlets." As of the last quarter of 1965, 30 of the 38 reporting States were sampling on a weekly basis.

The majority of States using gamma-ray spectrometry can report results for iodine–131 and cesium–137 within 3 days of sample collection.

While State surveillance programs for radioactivity in milk at the time the survey was conducted embraced more than three-fourths of the States, the survey results disclose no common denominators among the States with respect to selecting sampling locations or other sampling details. Where States or cities are supplied with interstate milk shipments, the need for uniformity in sampling procedures among the States is particularly important for effective radiation control programs, particularly those involving protective action procedures.

Acknowledgements

The authors wish to acknowledge with appreciation the efforts of State health department personnel who responded to the survey which produced the results summarized in this report, and to the nine Regional representatives of the National Center for Radiological Health, who were responsible for contacting the States and securing the completed forms.

REFERENCES

(*1*) PUBLIC HEALTH SERVICE. Summary statements on environmental sampling programs. Radiol Health Data 1:13–15 (April 1960).

(*2*) MARKARIAN, C. A., G. W. WILLIAMS, and G. OZOLINS. Summary of State radiological environment surveillance activities. Radiol Health Data 5: 447–450 (September 1964).

SECTION I. MILK AND FOOD

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Both Federal and State agencies are involved in efforts to monitor continuously the dietary intake of radionuclides. The most direct measure of radionuclide intake would be obtained through radioanalysis of the total diet. Difficulties in obtaining specific dietary data impede this approach. An alternate method entails the use of indicator foods to arrive at an estimate of the total dietary radionuclide intake.

Milk is one such indicator food. It is consumed by a large segment of the U.S. population and contains most of the biologically significant radionuclides which appear in the diet. It also is one of the major sources of dietary intake for the short-lived radionuclides. For these reasons, milk is the single food item most often used in estimating the intake of selected radionuclides by the general population and/or specific population groups. In the absence of specific dietary information, it is possible to approximate the total daily dietary intake of selected radionuclides as being equivalent to the intake represented by the consumption of 1 liter of milk.

The Federal Radiation Council (FRC) has developed Radiation Protection Guides (RPG's) for controlling normal peacetime nuclear operations, assuming continuous exposure from intake by the population at large (1–3). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other. They do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the FRC Protective Action Guides (*4*) and by the International Commission on Radiological Protection (*5,6*).

Data from selected national, international, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling has been defined as one or more samples collected per month.

REFERENCES

(*1*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 13, 1960).

(*2*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402 (September 1960).

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, protective action for strontium–89, strontium–90, and cesium–137, Report No. 7. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (July 1964).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 5. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1965).

(*5*) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendation of the International Commission on Radiological Protection, Report No. 2. Pergamon Press, New York, N.Y. (1959).

(*6*) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendation of the International Commission on Radiological Protection, Report No. 6. Pergamon Press, New York, N.Y. 1965).

National and International Milk Surveillance

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various national and international organizations routinely monitor radionuclide levels in milk. In addition to those programs reported below, *Radiological Health Data and Reports* coverage includes:

Program	Period reported	Last presented
Radiostrontium in milk, HASL	July–December 1966	September 1967

1. Pasteurized Milk Network July 1967

National Center for Radiological Health and *National Center for Urban and Industrial Health, PHS*

The Public Health Service's Pasteurized Milk Network (PMN) was designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 stations (figure 1) provides data on milk in every State, the Canal Zone, and Puerto Rico. The most recent description of the sampling and analytical pro-

Table 1. Analytical errors associated with determinations of radionuclide concentrations in milk

Radionuclide	Concentration (pCi/liter)	Error [a] (pCi/liter)	Concentration (pCi/liter)	Error [a] (percent of concentration)
Strontium-89	< 50	5	≥50	10
Strontium-90	< 20	2	≥20	10
Iodine-131	<100	10	≥100	10
Cesium-137	<100	10	≥100	10
Barium-140	<100	10	≥100	10

[a] Two standard deviations.

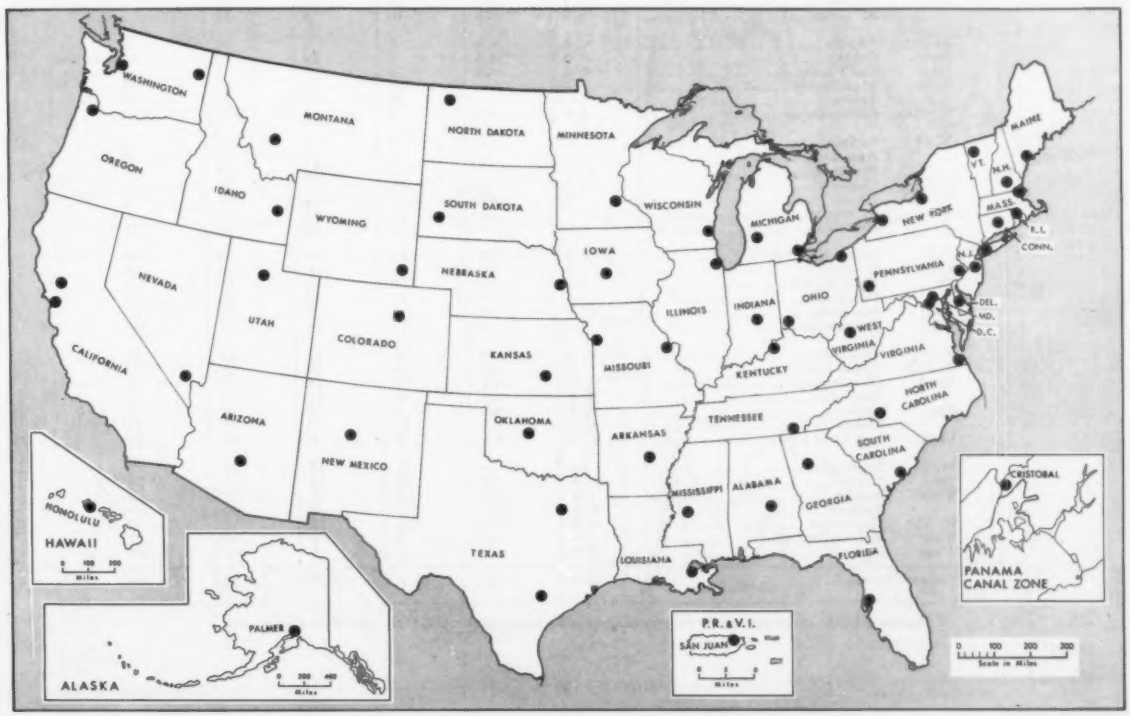

Figure 1. Pasteurized Milk Network sampling stations

Table 2. Average concentrations of radionuclides in pasteurized milk for the second quarter 1967 and July 1967

Sampling location		Radionuclide concentration (pCi/liter)					
		Strontium-89		Strontium-90		Cesium-137	
		Second quarter 1967 [a]	July [a] 1967	Second quarter 1967	July 1967	Second quarter 1967	July 1967
Ala:	Montgomery	< 5	<5	10	10	15	15
Alaska:	Palmer	< 5	<5	7	6	20	20
Ariz:	Phoenix	< 5	<5	4	2	< 5	5
Ark:	Little Rock	< 5	<5	27	25	20	20
Calif:	Sacramento	10	<5	5	4	10	10
	San Francisco	10	<5	5	3	10	5
C.Z:	Cristobal	< 5	<5	5	5	30	20
Colo:	Denver	< 5	<5	6	8	10	15
Conn:	Hartford	—	—	9	11	20	20
Del:	Wilmington	—	—	12	12	15	15
D.C:	Washington	< 5	<5	10	11	15	10
Fla:	Tampa	< 5	<5	9	8	75	70
Ga:	Atlanta	< 5	<5	17	16	25	25
Hawaii:	Honolulu	< 5	<5	4	5	10	10
Idaho:	Idaho Falls	< 5	<5	7	7	10	15
Ill:	Chicago	< 5	<5	10	7	15	10
Ind:	Indianapolis	—	—	10	10	15	10
Iowa:	Des Moines	< 5	<5	9	9	15	10
Kans:	Wichita	5	<5	8	9	10	10
Ky:	Louisville	< 5	<5	15	14	10	15
La:	New Orleans	< 5	<5	28	21	30	30
Maine:	Portland	—	—	12	13	35	35
Md:	Baltimore	< 5	<5	13	11	20	10
Mass:	Boston	< 5	<5	12	14	35	35
Mich:	Detroit	—	—	9	9	15	15
	Grand Rapids	—	—	11	12	25	15
Minn:	Minneapolis	< 5	<5	14	15	20	15
Miss:	Jackson	< 5	<5	21	21	20	15
Mo:	Kansas	5	<5	10	11	10	< 5
	St. Louis	5	<5	10	9	10	< 5
Mont:	Helena	< 5	<5	6	6	10	10
Nebr:	Omaha	< 5	<5	8	14	10	10
Nev:	Las Vegas	< 5	<5	2	3	5	5
N.H:	Manchester	—	—	15	18	50	50
N.J:	Trenton	—	—	10	10	20	15
N. Mex:	Albuquerque	< 5	<5	3	3	< 5	< 5
N.Y:	Buffalo	—	—	9	8	20	15
	New York	—	—	12	15	20	20
	Syracuse	—	—	9	10	20	15
N.C:	Charlotte	< 5	<5	19	17	20	20
N. Dak:	Minot	5	<5	17	12	25	15
Ohio:	Cincinnati	—	—	11	11	15	10
	Cleveland	—	—	11	10	20	15
Okla:	Oklahoma City	< 5	<5	12	10	10	10
Ore:	Portland	5	<5	10	10	20	20
Pa:	Philadelphia	—	—	10	9	15	10
	Pittsburgh	—	—	15	14	25	20
P.R:	San Juan	< 5	<5	4	7	15	15
R.I:	Providence	—	—	11	14	25	30
S.C:	Charleston	< 5	<5	16	17	35	30
S. Dak:	Rapid City	5	<5	14	12	15	20
Tenn:	Chattanooga	< 5	<5	17	18	20	20
	Memphis	< 5	<5	16	14	10	10
Tex:	Austin	< 5	<5	4	3	10	5
	Dallas	< 5	<5	12	10	15	15
Utah:	Salt Lake City	< 5	<5	6	6	15	20
Vt:	Burlington	—	—	11	13	25	20
Va:	Norfolk	< 5	<5	14	14	15	15
Wash:	Seattle	5	<5	12	11	35	45
	Spokane	< 5	<5	12	9	20	20
W. Va:	Charleston	< 5	<5	15	13	15	10
Wisc:	Milwaukee	—	—	7	9	20	15
Wyo:	Laramie	< 5	<5	5	5	10	10
Network average		< 5	<5	10.9	10.7	20	15

[a] Dashes indicate no strontium-89 determinations were made on samples from station during month.

cedures employed by the PMN appeared in the December 1966 issue of *Radiological Health Data and Reports* (*1*).

Table 1 shows the approximate analytical errors (including counting error) associated with determinations of radionuclide concentrations in milk. These errors were determined by comparing results of a large number of replicate analyses. The minimum detectable concentration is defined as the measured concentration equal to 2 standard deviations of the analytical error. Accordingly, the minimum detectable concentrations in units of pCi/liter are: strontium–89, 5; strontium–90, 2; cesium–137, 10; barium–140, 10; and iodine–131, 10. At these levels and below, the counting error comprises nearly all of the analytical error. The results for the second quarter of 1967 and July 1967, are presented in table 2. The average monthly radionuclide concentrations are based on results obtained from samples collected weekly. If radionuclide values are below minimum detectable concentrations, averages are calculated using one-half of the minimum detectable values; however, for iodine–131 and barium–140, zero is used for averaging purposes when concentrations are below minimum detectable levels. Because all values for iodine–131 and barium–140 are below minimum detectable concentrations during the period covered in this report, results for these two radionuclides are not included in table 2.

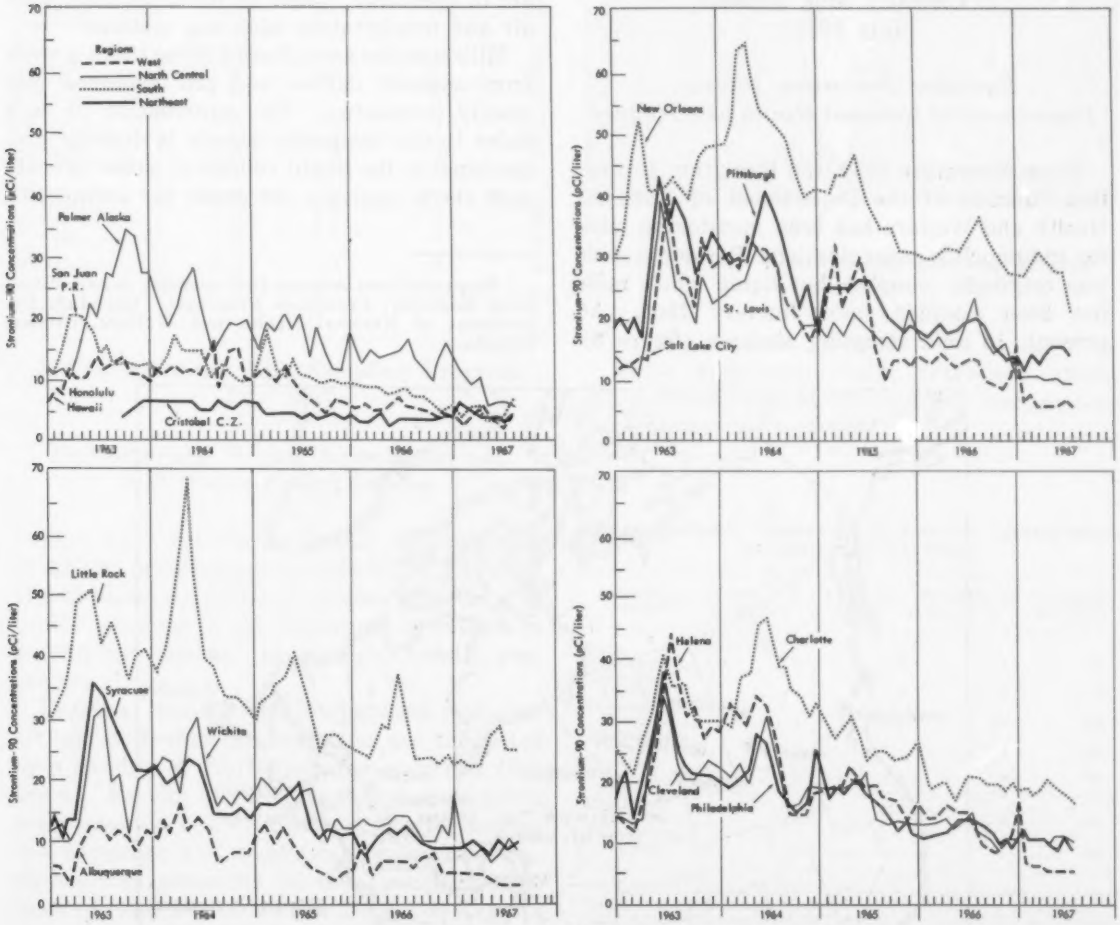

Figure 2. Strontium-90 concentrations in pasteurized milk, 1961–July 1967

For comparative purposes, distributions of strontium–90 and cesium–137 are presented in tables 3 and 4 for July 1966 and February through July 1967. The average strontium–90 concentrations in pasteurized milk from selected cities are presented in figure 2.

Table 3. Frequency distribution, strontium-90 concentrations in milk at PMN stations, July 1966, February–July 1967

Strontium-90 (pCi/liter)	Number of stations [a]													
	1966	1967												
	July	Feb		Mar		Apr		May		June		July		
Under 10	14	(22%)	21	(33)	25	(40)	25	(40)	25	(40)	27	(43)	25	(40)
10–19	39	(62)	38	(61)	35	(55)	34	(54)	35	(55)	34	(54)	35	(55)
20–29	9	(14)	4	(6)	2	(3)	4	(6)	3	(5)	2	(3)	3	(5)
30–39	1	(2)	0	(0)	1	(2)	0	(0)	0	(0)	0	(0)	0	(0)

[a] Percentage of stations shown in parentheses.

Table 4. Frequency distribution, cesium-137 concentrations in milk at PMN stations, July 1966, February–July 1967

Cesium-137 (pCi/liter)	Number of stations [a]													
	1966	1967												
	July	Feb		Mar		Apr		May		June		July		
Under 50	56	(89%)	62	(98)	62	(98)	62	(98)	61	(97)	61	(97)	61	(97)
50–99	6	(9)	1	(2)	1	(2)	1	(2)	2	(3)	2	(3)	2	(3)
100–140	1	(2)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)

[a] Percentage of stations shown in parentheses.

2. Canadian Milk Network July 1967 [1]

Radiation Protection Division
Department of National Health and Welfare

Since November 1955, the Radiation Protection Division of the Department of National Health and Welfare has been monitoring milk for radionuclide concentrations. Powdered milk was originally sampled, but liquid whole milk has been sampled since January 1963. At present, 16 milk sampling stations (figure 3) are in operation. Their locations coincide with air and precipitation sampling stations.

Milk samples are collected three times a week from selected dairies and are combined into weekly composites. The contribution of each dairy to the composite sample is directly proportional to the liquid volume of sales. Weekly spot check analyses are made for iodine–131,

[1] Prepared from August 1967 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

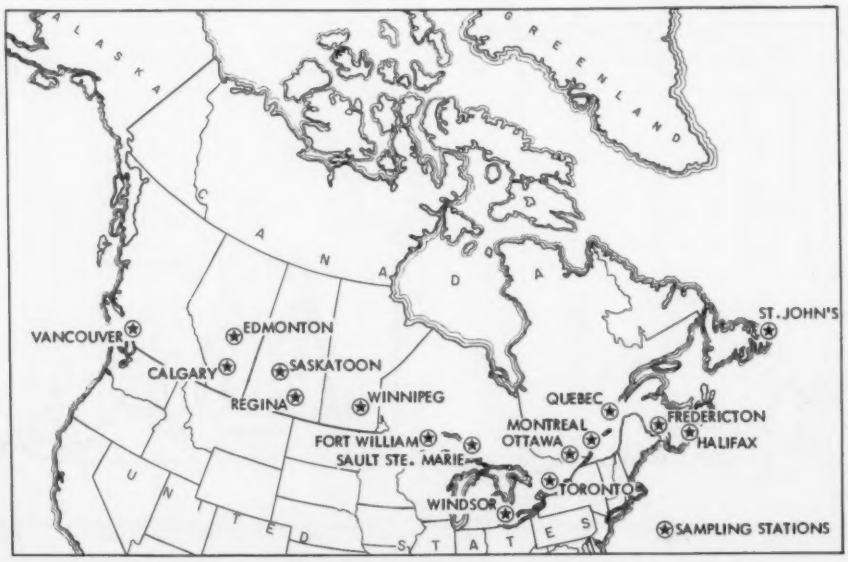

Figure 3. Canadian milk sampling stations

and monthly composites are analyzed for strontium–90, cesium-137, and stable calcium and potassium. The analytical procedures were outlined in the December 1966 issue of *Radiological Health Data and Reports* (*2*).

The July 1967 monthly average strontium–90, cesium–137, and stable calcium and potassium concentrations in Canadian whole milk are presented in table 5. Iodine–131 and strontium–89 concentrations were below minimum detectable levels.

Table 5. Stable elements and radionuclides in Canadian whole milk, July 1967

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.12	1.5	12	19
Edmonton	1.10	1.6	10	25
Ft. William	1.09	NS	18	NS
Fredericton	1.03	1.4	21	17
Halifax	1.10	1.6	21	32
Montreal	1.05	1.5	10	19
Ottawa	1.13	NS	11	NS
Quebec	1.06	1.5	18	25
Regina	1.08	1.6	10	14
St. John's, Nfld	1.16	1.6	34	85
Saskatoon	1.08	1.6	10	13
Sault Ste. Marie	1.10	1.7	19	34
Toronto	1.11	1.6	8	7
Vancouver	1.18	1.5	16	63
Windsor	1.13	1.5	8	10
Winnipeg	1.08	1.6	9	22
Average	1.10	1.6	15	38

NS, no sample.

3. Pan American Milk Sampling Program July 1967

Pan American Health Organization and *U.S. Public Health Service*

The Pan American Health Organization (PAHO), in collaboration with the U.S. Public Health Service (PHS), furnishes assistance to health agencies in the American Republics in developing national radiological health programs.

Under a joint agreement between agencies, air and milk sampling activities are conducted by a number of PAHO member countries (figure 4). Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1966 issue of *Radiological Health Data and Reports* (*3*).

Figure 4. Pan American Milk Sampling Program locations

Table 6 presents stable potassium, strontium–90, and cesium–137 monthly average concentrations for July 1967.

Table 6. Stable element and radionuclide concentrations in PAHO milk, July 1967 [a]

Sampling station	Number of samples	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Chile:				
Santiago	4	1.6	4	15
Colombia:				
Bogota	1	1.4	3	< 5
Ecuador:				
Guayaquil	1	1.5	<1	10
Jamaica:				
Kingston	1	1.5	6	105
Venezuela:				
Caracas	1	1.5	4	10
Canal Zone:				
Cristobal [b]	5	----------	5	20
Puerto Rico:				
San Juan [b]	5	----------	7	15

[a] Iodine-131 and barium-140 determinations were less than 10 pCi/liter for all samples. Strontium-89 was less than 5 pCi/liter for all samples.

[b] For comparison purposes, the radionuclide concentrations at Cristobal, Canal Zone and San Juan, Puerto Rico, from the Pasteurized Milk Network, are presented.

REFERENCES

(1) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, August 1966. Radiol Health Data Rep 7:698–701 (December 1966).

(2) DEPARTMENT OF NATIONAL HEALTH AND WELFARE, RADIATION PROTECTION DIVISION. Canadian Milk Network, August 1966. Radiol Health Data Rep 7:702–703 (December 1966).

(3) PAN AMERICAN HEALTH ORGANIZATION and U.S. PUBLIC HEALTH SERVICE. Pan American Milk Sampling Program, August 1966. Radiol Health Data Rep 7:704–705 (December 1966).

State Milk Surveillance Activities

Considerable progress has been made by the State health departments in initiating or expanding environmental surveillance activities in radiological health. Many of the States have reached a point of having comprehensive environmental surveillance programs and self-sustaining radiological health laboratories.

The continuing efforts of State health departments in the analysis and monitoring of radionuclides in milk complement Federal milk surveillance activities. State milk surveillance activities are continually undergoing developmental changes. The results presented herein are representative of current surveillance activities directed at the use of milk as an indicator of dietary intake of radioactivity.

Figure 1 shows the States which report milk surveillance activities in *Radiological Health Data and Reports*. States having programs appearing in the current issue are highlighted in the figure. A summary of State programs previously covered, the reporting period, and issue of appearance are as follows:

State milk network	Period reported	Last presented
California	January–March 1967	September 1967
Colorado	April–June 1967	October 1967
Florida	April–June 1967	October 1967
Oklahoma	April–June 1967	October 1967
Oregon	January–March 1967	September 1967
Tennessee	April–June 1967	October 1967
Texas	April–June 1967	October 1967
Washington	January–March 1967	September 1967

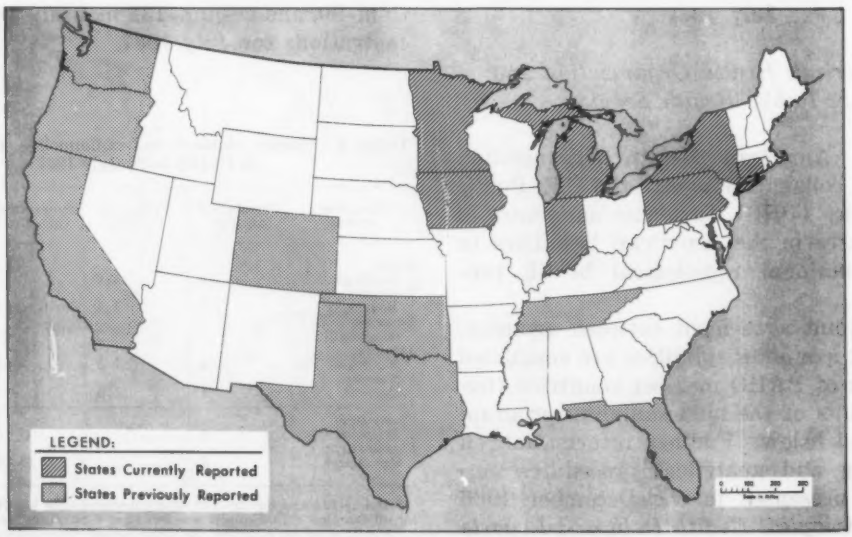

Figure 1. State milk programs reported

1. Connecticut Milk Network April–June 1967

Connecticut State Department of Health

The Connecticut State Department of Health has been monitoring pasteurized milk for strontium–89 and strontium–90 since April 1960. In May 1962, the program was expanded to include the determination of gamma-emitting radionuclides in milk.

The sampling program is flexible in nature, providing for sampling in five areas of the State (figure 2). At the present time, weekly samples representative of milk sold in the central area of the State are collected and analyzed for strontium–89, strontium–90, and gamma-ray emitters. Concentrations of iodine–131 are determined as an indication of the presence of radioactivity of recent origin.

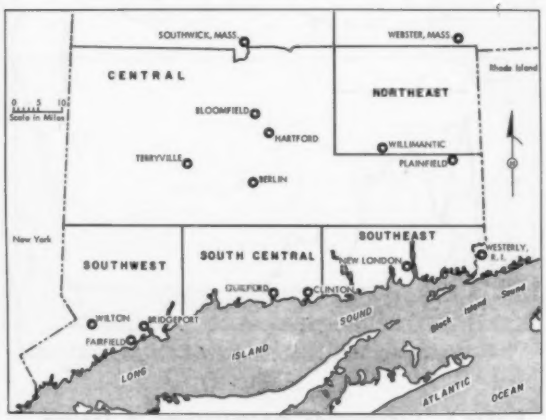

Figure 2. Connecticut pasteurized milk sampling areas

Strontium–89 and strontium–90 are determined by chemical separation. Iodine–131 and other gamma-ray emitters are determined by gamma-ray scintillation spectroscopy.

The monthly average concentrations of strontium–89, strontium–90, iodine–131, and cesium–137 in central Connecticut pasteurized milk are presented in table 1. These results are presented graphically in figure 3.

Table 1. Radionuclide concentrations in central Connecticut pasteurized milk, April–June 1967

Month	Radionuclide concentrations (pCi/liter)			
	Strontium-89	Strontium-90	Iodine-131	Cesium-137
April	ND	10	<10	20
May	ND	9	<10	20
June	ND	11	<10	20

ND, below detectable levels.

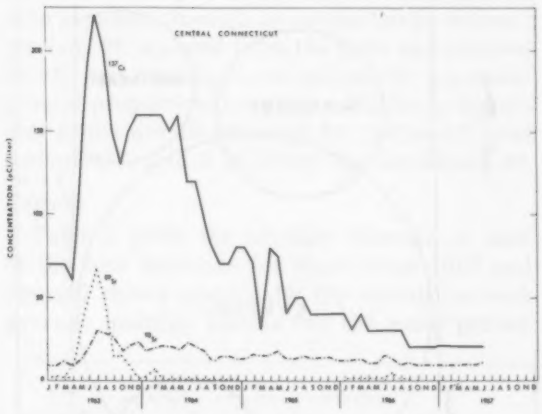

Figure 3. Radionuclide concentration in central Connecticut pasteurized milk, 1963–June 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
October–December 1966	May 1967
January–March 1967	August 1967

Recent coverage in *Radiological Health Data and Reports for Indiana Milk Network:*

Period	Issue
October–December 1966	May 1967
January–March 1967	August 1967

2. Indiana Milk Network April–June 1967

Bureau of Environmental Sanitation
Indiana State Board of Health

The Indiana State Board of Health began sampling pasteurized milk for radionuclide analysis in September 1961. The State was geographically divided into five major milksheds: northeast, northwest, central, southeast, and southwest (figure 4). One large dairy within each milkshed was assumed to be representative for sampling purposes.

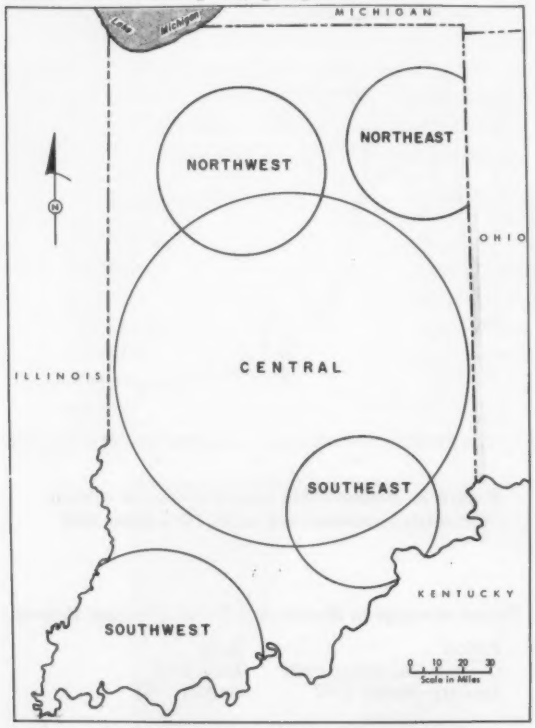

Figure 4. Indiana pasteurized milk sampling areas

The milk samples are analyzed monthly for strontium–89 and strontium–90. Cesium–137, iodine–131, and barium–140 are analyzed weekly for at least two of the milksheds. When iodine–131 concentrations exceed 100 pCi/liter, the sampling frequency is increased. From August 1963 to April 1966, because of the continued low concentrations of short-lived radionuclides, the sampling frequency was once a month for the northeast, southeast, and southwest milksheds.

Strontium–89 and strontium–90 concentrations in milk samples are determined by ion exchange separation (*1,2*) while cesium–137, iodine–131, and barium–140 are determined by gamma-ray scintillation spectrometry (*3*).

The monthly stable element and radionuclide concentrations in Indiana pasteurized milk are presented by sampling locations in table 2 for April through June 1967.

The monthly network average concentrations of strontium–89, strontium–90, and cesium–137 are presented graphically in figure 5. Barium–140 concentrations remained below detectable levels of 10 pCi/liter during this period.

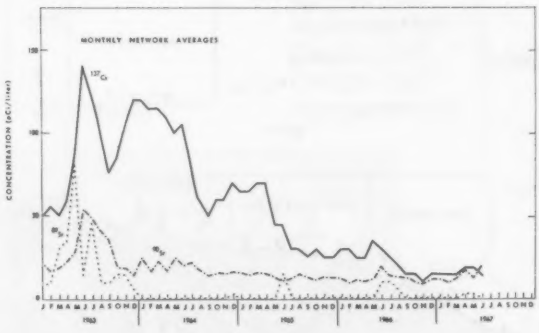
MONTHLY NETWORK AVERAGES
CONCENTRATION (pCi/liter)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1963
1964
1965
1966
1967

Figure 5. Radionuclide concentrations in Indiana pasteurized milk, 1963–June 1967

Table 2. Radionuclides in Indiana pasteurized milk, April–June 1967

Sampling location	Calcium (g/liter)			Potassium-40 (pCi/liter)			Strontium-89 (pCi/liter)			Strontium-90 (pCi/liter)			Cesium-137 (pCi/liter)		
	April	May	June	April	May	June	April	May	June	April	May	June	April	May	June
Northeast	1.10	1.22	1.15	1,360	1,370	1,330	5	0	0	14	14	30	20	20	15
Southeast	1.10	1.26	1.20	1,380	1,290	1,330	0	10	0	19	15	20	20	20	15
Central	1.14	1.22	1.15	1,330	1,310	1,310	10	5	0	21	11	20	10	15	10
Southwest	1.14	1.22	1.20	1,300	1,370	1,330	20	5	0	25	16	18	20	20	10
Northwest	1.16	1.20	1.10	1,300	1,350	1,330	0	0	0	16	14	19	20	20	15
Average	1.13	1.22	1.16	1,330	1,340	1,330	5	5	0	19	14	21	20	20	15

3. Iowa Milk Network April–June 1967

State Hygienic Laboratory and the *Iowa State Department of Health*

In Iowa, radiological health activities are conducted jointly by the State Department of Health and the State Hygienic Laboratory, with the State Hygienic Laboratory performing the surveillance and analytical functions. In August 1962, the State Hygienic Laboratory of Iowa began sampling milk for iodine–131. In May 1964 this routine surveillance was expanded to include cesium–137 and strontium–90.

One gallon samples are collected from four stations, selected to give a broad coverage of milk production areas in the State (figure 6). Producers furnishing milk to the Spencer bottling area are restricted to that northwest part of the State and the majority of milk bottled in Iowa City comes from six counties in east central Iowa. The Des Moines milkshed comprises approximately 60 counties covering about two-thirds of the State radiating out of Des Moines in all directions. The Charles City bottling area covers primarily north central Iowa. At present the Iowa City and Des Moines stations are sampled weekly and the Spencer and Charles City stations are sampled monthly. This sampling frequency is increased when nuclide concentrations warrant closer surveillance. The samples are forwarded to the State Hygienic Laboratory at the University of Iowa, Iowa City, for analysis.

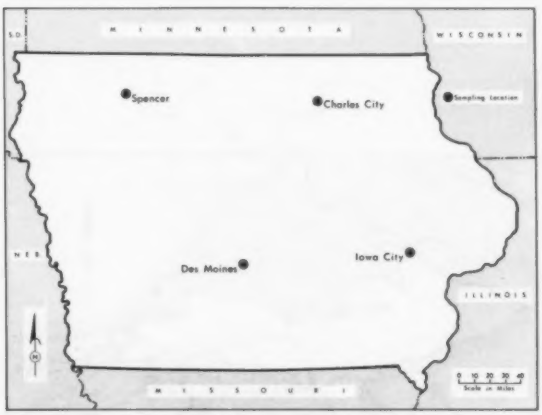

Figure 6. Iowa milk sampling locations

Analytical procedures

Iodine–131 and cesium–137 together with barium-lanthanum–140 and potassium–40 are determined by gamma-ray scintillation spectrometry using a 4- by 4-inch NaI (TI) crystal and 512 channel pulse-height analyzer. All samples are 3.5 liters and are counted for 80 minutes in Marinelli beakers with the results being calculated using a 4 by 4 matrix. Strontium–90 is determined by an ion-exchange system described by Porter *et al.* (*1*). One liter of milk is passed through an ion exchange column; yttrium–90 is eluted from the resin and counted as yttrium oxalate in an automatic low-background proportional counter. Minimum detectable limits are 10 pCi/liter for iodine–131 and cesium–137, and 2 pCi/liter for strontium–90.

Results

Table 3 gives the monthly average at each of the four locations for April–June 1967 and figure 7 shows graphically the overall network average monthly results for the same period.

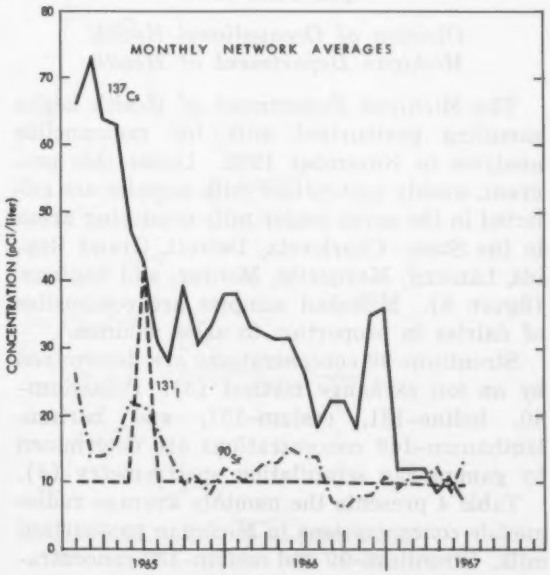

Figure 7. Radionuclide concentrations in Iowa milk January 1965–June 1967

Table 3. Radionuclide concentrations in Iowa milk, April–June 1967

Sampling location	Radionuclide concentrations (pCi/liter)								
	Strontium-90			Cesium-137			Iodine-131		
	April	May	June	April	May	June	April	May	June
Iowa City	12	9	10	11	8	9	<10	<10	<10
Des Moines	10	8	12	7	7	9	<10	<10	<10
Spencer	13	NA	NA	13	NA	NA	<10	NA	NA
Charles City	13	9	17	<10	19	<10	<10	<10	<10
Average	12	9	13	9	11	8	<10	<10	<10

NA, no analysis to date.

During this period it can be seen that the concentration levels of cesium–137 and strontium–90 showed a decreasing trend.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–1965–March 1967	August 1967

4. Michigan Milk Network April–June 1967

Division of Occupational Health
Michigan Department of Health

The Michigan Department of Health began sampling pasteurized milk for radionuclide analyses in November 1962. Under this program, weekly pasteurized milk samples are collected in the seven major milk producing areas in the State: Charlevoix, Detroit, Grand Rapids, Lansing, Marquette, Monroe, and Saginaw (figure 8). Milkshed samples are composites of dairies in proportion to sales volumes.

Strontium–90 concentrations are determined by an ion exchange method (*5*). Potassium–40, iodine–131, cesium–137, and barium-lanthanum–140 concentrations are determined by gamma-ray scintillation spectrometry (*5*).

Table 4 presents the monthly average radionuclide concentrations in Michigan pasteurized milk. Strontium–90 and cesium–137 concentrations are presented graphically in figure 9 to show general trends.

Figure 8. Michigan pasteurized milk network sampling locations

Table 4. Radionuclide concentrations in Michigan pasteurized milk, April–June 1967

Sampling location	Month	Radionuclide concentration (pCi/liter)			
		Potassium-40	Strontium-90	Iodine-131	Cesium-137
Charlevoix	April	1,360	6	<14	20
	May	1,300	8	<14	23
	June	1,360	6	<14	20
Detroit	April	1,370	4	<14	14
	May	1,370	4	<14	15
	June	1,320	4	<14	10
Grand Rapids	April	1,360	5	<14	16
	May	1,350	7	<14	17
	June	1,320	6	<14	13
Lansing	April	1,350	4	<14	13
	May	1,330	6	<14	14
	June	1,370	4	<14	9
Marquette	April	1,380	10	<14	28
	May	1,390	7	<14	30
	June	1,330	10	<14	26
Monroe	April	1,360	3	<14	10
	May	1,360	10	<14	10
	June	1,380	4	<14	9
Saginaw	April	1,360	3	<14	11
	May	1,330	5	<14	15
	June	1,290	4	<14	10
Average	April	1,360	5	<14	16
	May	1,350	7	<14	18
	June	1,340	5	<14	14

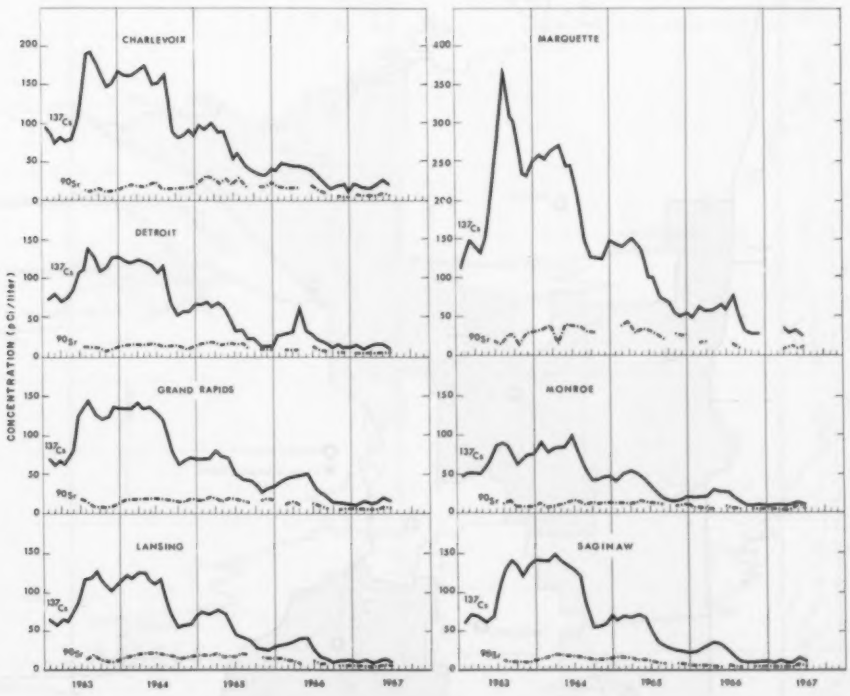

Figure 9. Radionuclide concentrations in Michigan pasteurized milk 1963–June 1967

5. Minnesota Milk Network April–June 1967

Division of Environmental Health
Minnesota Department of Health

In September 1958, the Minnesota Department of Health initiated a pasteurized milk network to monitor strontium–90 concentrations. Presently, monthly samples are collected from eight sampling locations in milksheds geographically the same as the Minnesota Health districts (figure 10) and analyzed for strontium–90, iodine–131, and cesium–137. One-liter samples of processed Grade A fluid milk are collected at bottling machines in pasteurization plants. The samples are customarily collected in the cities where the Minnesota Health Department district offices are located. However, it is sometimes convenient to collect at other locations. Such samples are considered representative of the district concerned.

Strontium–90 concentrations are determined radiochemically, while iodine–131 and cesium–137 concentrations are determined by gamma-ray scintillation spectrometry. The analytical procedures are presented in the semiannual report of the Minnesota Department of Health and the Rural Cooperative Power Association (*6*).

Strontium–90 and cesium–137 concentrations in milk are given for April through June 1967 in table 5, and are presented graphically by milkshed in figure 11 for the period 1961 through June 1967. Iodine–131 concentrations were less than 10 pCi/liter in all 24 samples.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
October–December 1966	May 1967
January–March 1967	August 1967

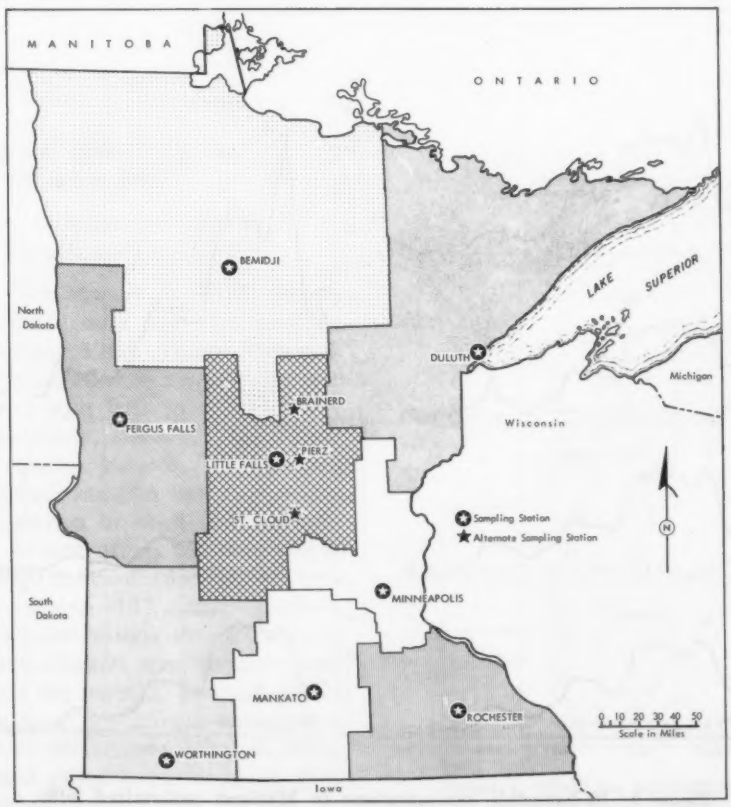

Figure 10. Minnesota milk sampling locations

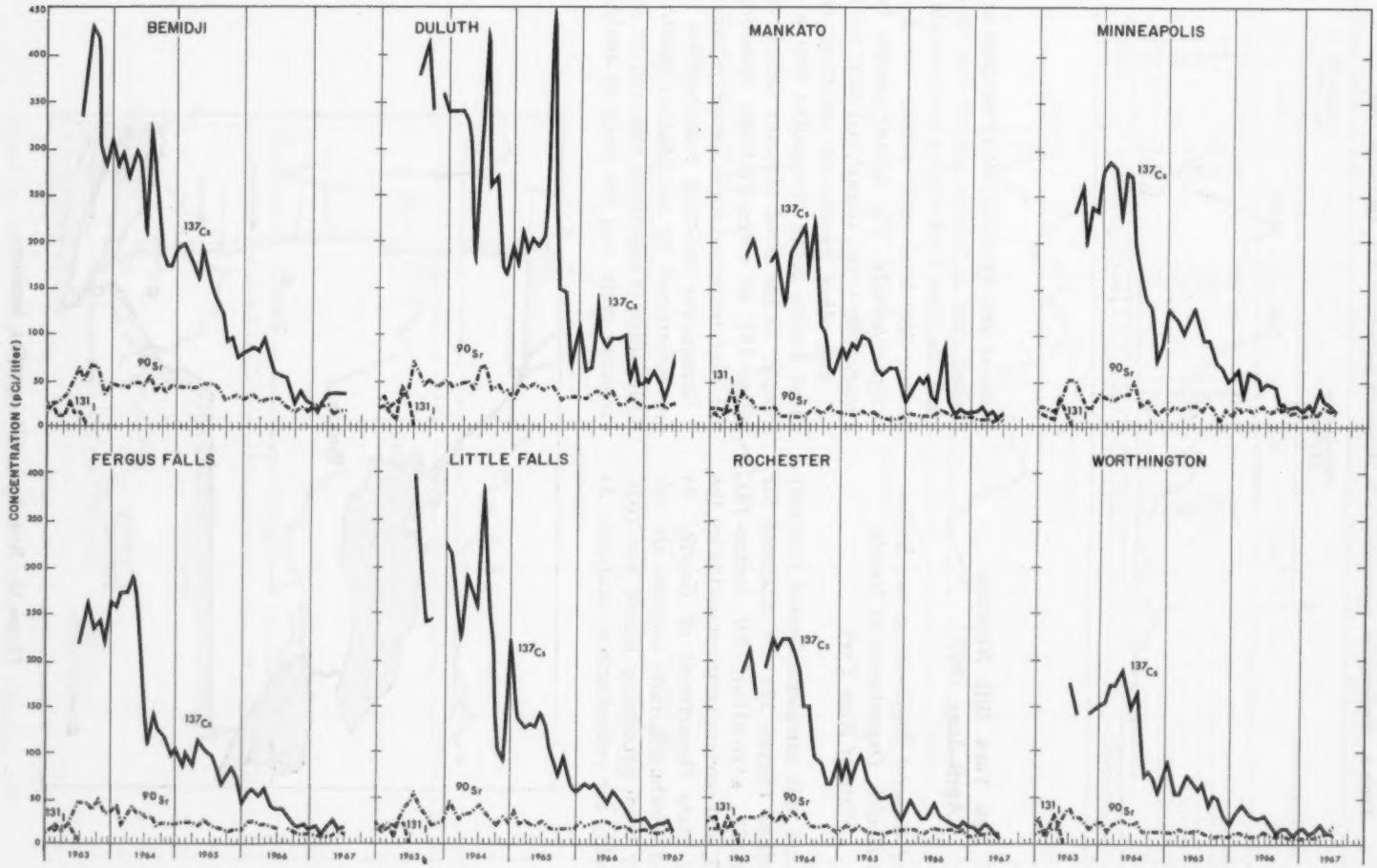

Figure 11. Radionuclide concentrations in Minnesota milk, 1963–June 1967

Table 5. Radionuclide concentrations in Minnesota pasteurized milk, April–June 1967

Sampling location	Strontium-90 (pCi/liter)			Cesium-137 (pCi/liter)		
	April	May	June	April	May	June
Bemidji	16	18	18	36	33	32
Mankato	5	8	7	17	8	14
Rochester	10	10	10	18	10	7
Duluth	18	20	24	22	35	66
Worthington	10	8	17	23	11	10
Minneapolis	17	15	13	19	17	14
Fergus Falls	9	11	9	23	13	13
Little Falls	13	15	14	24	26	12
Average	12	13	14	23	19	21

6. New York Milk Network April–June 1967

Division of General Engineering and Radiological Health, Department of Health, State of New York

Pasteurized milk samples collected routinely from six cities (figure 12) are analyzed for strontium–89, strontium–90, iodine–131, cesium–137, and barium-lanthanum–140 by the New York State Department of Health. At Buffalo and Newburgh, milk samples are collected daily from processing plants and composited weekly for radiochemical analyses. At Messena and Syracuse, daily samples are composited over a 2-week period and then analyzed. In New York City, a milk sample representing the total milk supply for 1 day is analyzed weekly. The Albany sample, taken at a marketing point, is analyzed daily for iodine–131 and other gamma-ray emitting radionuclides before being composited into a weekly sample. In the event that any sample contains iodine–131 at concentrations exceeding 100 pCi/liter, increased surveillanced is undertaken.

Gamma-ray emitting radionuclides in milk are determined by scintillation spectrometry. Radioiodine is selectively removed by an anion exchange resin and the resin is analyzed for

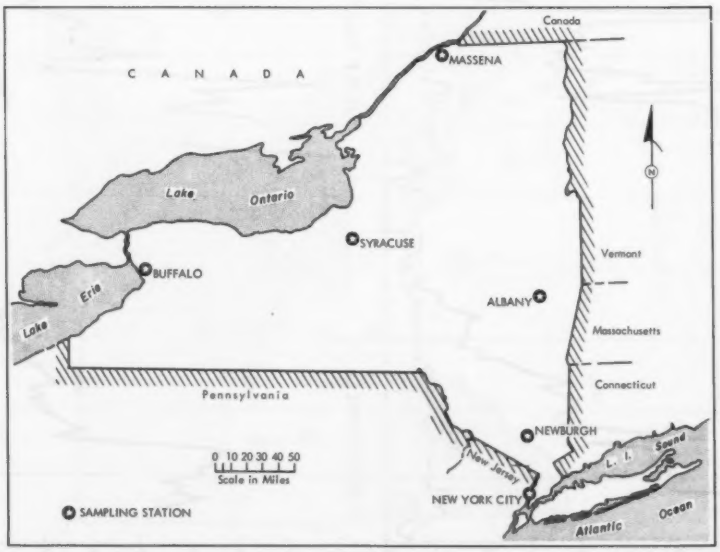

Figure 12. New York milk sampling locations

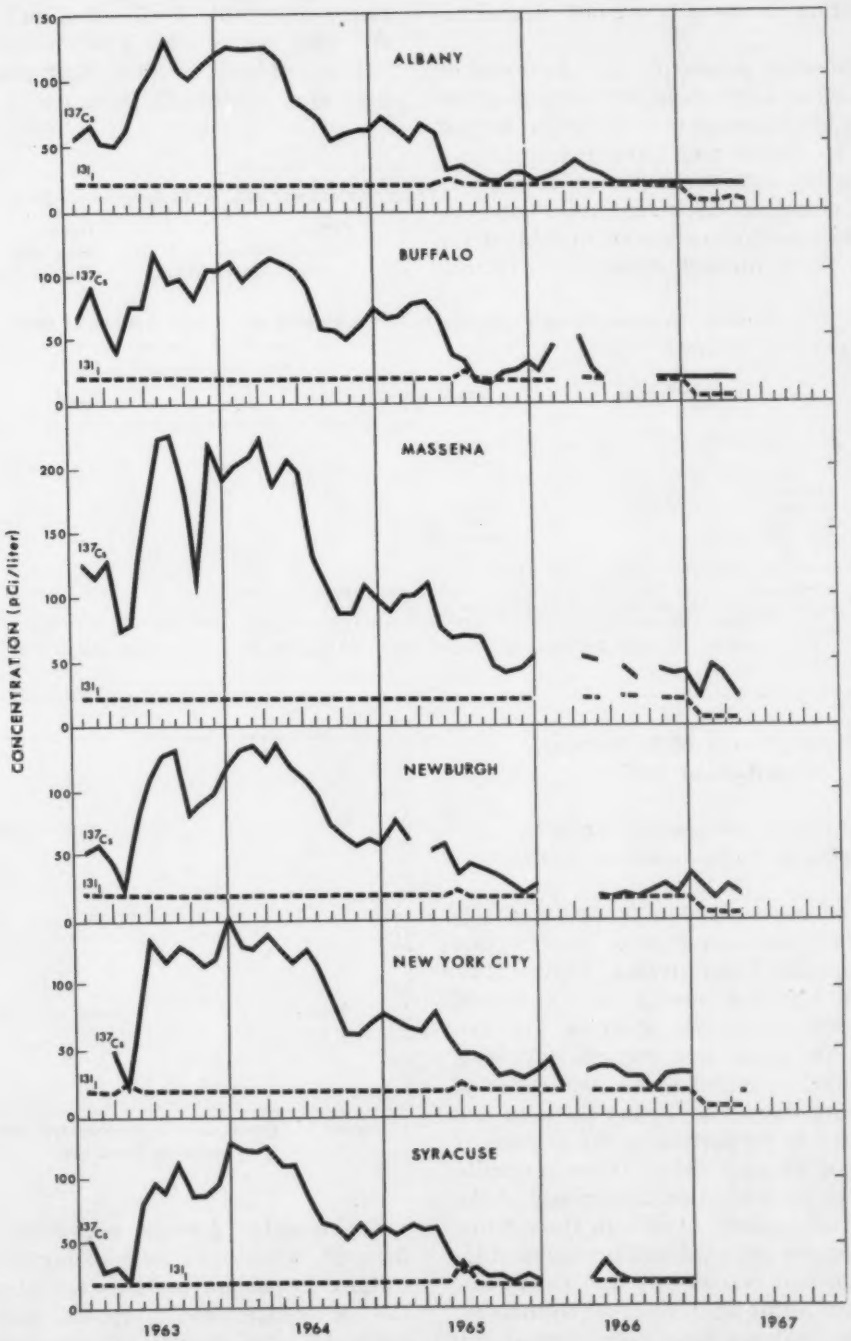

Figure 13. Radionuclide concentrations in New York milk, 1963–June 1967

iodine–131 (*7,9*). The resin effluent is analyzed and the resulting spectral data is resolved by the application of a matrix method of analysis (*8*).

The analytical procedure for determining strontium–89 and strontium–90 concentrations employs an ion exchange system similar to that developed by Porter and Kahn (*2*).

The monthly average radionuclide concentrations of strontium–89, strontium–90, iodine–131, and cesium–137 are shown in table 6 for the period April through June 1967. During this period, essentially all iodine–131 and strontium–89 concentrations were below their minimum detectable levels of 5 pCi/liter and 3 pCi/liter, respectively. Cesium–137 and iodine–131 concentrations since September 1961 are presented graphically in figure 13.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
October–December 1966	May 1967
January–March 1967	August 1967

Table 6. Radionuclide concentrations in New York pasteurized milk, April–June 1967

Sampling location	Month	Radionuclide concentrations (pCi/liter)			
		Strontium-89	Strontium-90	Iodine-131	Cesium-137
Albany	April	<3	16	6	<20
	May [a]				
Buffalo [b]	April	<3	6	<5	<20
Massena [b]	April	<3	9	<5	<20
Newburg [b]	April	<3	5	<5	23
New York [b]	April	<3	11	<5	<20
Syracuse [b]					

[a] No analysis given for May 1967 for strontium-89 or strontium-90 because of laboratory move. No analysis given for the month of June also because of laboratory move.
[b] No analysis given for the months May and June 1967 because of laboratory move. Syracuse not reported for all 3 months.
Detectable limits: iodine-131, 5 pCi/liter; strontium-89, 3 pCi/liter: strontium-90, 3 pCi/liter; and cesium-137, 20 pCi/liter.

7. Pennsylvania Milk Network April–June 1967

Bureau of Environmental Health
Pennsylvania Department of Health

Samples of pasteurized milk are routinely collected from six major milk consumption areas throughout Pennsylvania (figure 14). Samples are collected weekly in Pittsburgh, while biweekly composite samples are collected from the other five stations. At each sampling location, subsamples are collected from the major dairies supplying the area and are composited in proportion to the amount of milk processed by each dairy. This composite is then sent to the Radiation Laboratory of the Division of Occupational Health in Harrisburg where the samples are analyzed for iodine–131, potassium–40, and cesium–137 and then composited for a monthly analysis of strontium–90. Strontium–90 analyses have been carried out since April 1963.

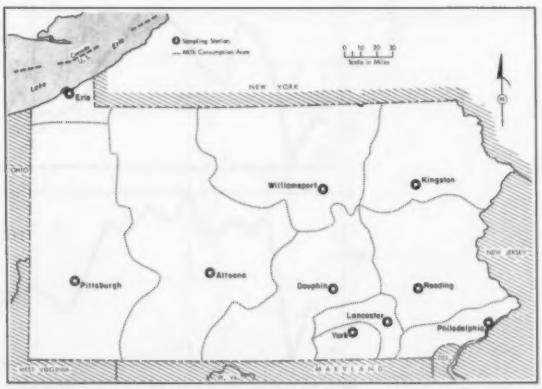

Figure 14. Pennsylvania pasteurized milk network sampling locations

The monthly average potassium–40, strontium–90, iodine–131, and cesium–137 concentrations in pasteurized milk are given in table 7. For comparative purposes, strontium–90, iodine–131, and cesium–137 concentrations are presented graphically in figure 15.

Table 7. Radionuclide concentrations in Pennsylvania pasteurized milk, April–June 1967

Sampling location	Radionuclide concentrations (pCi/liter)											
	Potassium-40			Strontium-90			Iodine-131			Cesium-137		
	April	May	June	April	May	June	April	May	June	April	May	June
Altoona	874	869	862	13	13	12	<10	<10	<10	20	18	16
Dauphin	819	857	776	10	9	8	<10	<10	ND	12	18	17
Erie	901	870	941	17	16	17	ND	ND	<10	23	26	29
Philadelphia	902	907	893	11	11	11	ND	<10	ND	16	22	15
Pittsburgh	881	882	858	14	19	14	<10	ND	<10	22	21	19
York	868	925	887	11	10	9	ND	<10	<10	19	13	16
Average	874	885	870	13	13	12	<10	<10	<10	19	20	19

ND, nondetectable.

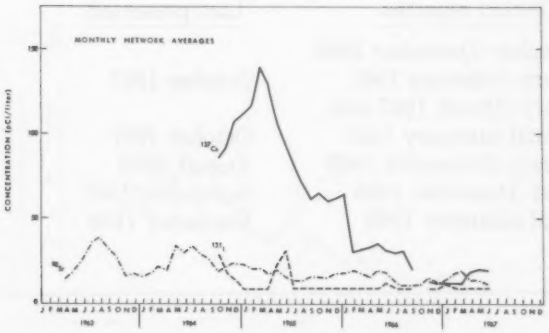
MONTHLY NETWORK AVERAGES
CONCENTRATION (pCi/liter)
137Cs
131I
90Sr
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1963
1964
1965
1966
1967

Figure 15. Radionuclide concentrations in Pennsylvania pasteurized milk, 1963–June 1967

The chemical separation technique for strontium–90 is essentially an ion exchange method described by Porter *et al.* (*1*).

Recent coverage in *Radiological Health Data and Reports*

Period	Issue
October–December 1966	May 1967
January–March 1967	August 1967

REFERENCES

(*1*) PORTER, C., D. CAHILL, R. SCHNEIDER, P. ROBBINS, W. PERRY and B. KAHN. Determination of strontium–90 in milk by an ion-exchange method. Anal Chem 33:1306–1308 (September 1961).

(*2*) PORTER, C., and B. KAHN. Improved determinations of strontium–90 in milk by an ion-exchange method. Anal Chem 36:676–678 (March 1964).

(*3*) INDIANA STATE BOARD OF HEALTH, BUREAU OF ENVIRONMENTAL SANITATION. Indiana milk network, April–June 1965. Radiol Health Data 6:612–614 (November 1965).

(*4*) PORTER, C., R. AUGUSTINE, J. MATUSEK, JR., and M. CARTER. Procedures for determination of stable elements and radionuclides in environmental samples, PHS Publication No. 999–RH–10. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (January 1965).

(*5*) MICHIGAN DEPARTMENT OF HEALTH. Michigan milk network, November 1962–December 1964. Radiol Health Data 6:487–492 (September 1965).

(*6*) MINNESOTA DEPARTMENT OF HEALTH AND RURAL COOPERATIVE POWER ASSOCIATION. Survey of environmental radioactivity, January–June 1965, COO–615–17 (August 1965).

(*7*) JOHNSON, R. H., and T. C. REAVEY. Evaluation of ion exchange cartridges for field sampling of iodine–131 in milk. Nature 208:750–752 (November 1965).

(*8*) KAHN, B., G. K. MURTHY, C. PORTER, G. R. HAGEE, G. J. KARCHES, and A. S. GOLDIN. Rapid methods for estimating fission product concentrations in milk, PHS Publication No. 999–R–2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1965).

(*9*) PORTER, C. R., and M. W. CARTER. Field method for rapid collection of iodine–131 from milk. Public Health Rep 80:453–456 (May 1965).

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Periodically, results from the United Kingdom Diet Survey, conducted by the United Kingdom Agricultural Research Council Radiobiological Laboratory, are presented for comparison with data observed in the United States. Programs most recently reported in *Radiological Health Data and Reports* and not covered in this issue are as follows:

Program	Period reported	Last presented
California Diet Study	September–December 1966 January–February 1967	October 1967
Institutional Diet, PHS	January–March 1967 and annual summary 1966	October 1967
Teenage Diet, FDA	February–November 1965	August 1966
Tri-City Diet, HASL	August–December 1966	September 1967
United Kingdom Diet, ARCRL	Annual summary 1965	December 1966

1. Estimated Daily Intake of Radionuclides in Connecticut Standard Diet, January-June 1967

Connecticut State Department of Health

The Connecticut State Department of Health has been analyzing a standard diet on a monthly basis since March 1963. Analysis are made for strontium–89, strontium–90, and gamma-ray emitters.

The standard diet was selected to represent the food intake of an 18-year-old boy for 1 day (table 1). The total weight of the complete blended diet, averaging 3 kilograms, included milk and dairy products. When raw fruit or vegetables were sampled, they were washed before blending.

Cesium–137 concentrations were determined by gamma-ray spectrometry (*1*). Strontium–89 and strontium–90 concentrations were determined by chemical separation techniques (*1*).

Table 2 presents the analytical results for the Connecticut standard diet from January through June 1967. Results representative of the total daily intake for the radionuclides observed are presented in table 3.

In order to evaluate general trends, the

Table 1. Foods included in standard diet

Bread, white—8 slices	Ice cream—½ pint
Butter ½ stick	Lettuce, washed—4–5 leaves
Carrots, scraped—½ cup	Milk—3 cups
Celery, washed and trimmed—3 stalks	Oatmeal, uncooked—43 grams
Cookies—4	Orange—1
Cottage cheese—½ cup	Peanut butter—2½ tablespoons
Cupcakes—2	Pears, canned—2 halves with juice
Egg—1	Potatoes, washed, not peeled—2
Green beans, washed—½ cup	Sugar—5 tablespoons
Ham—85 grams	Tomato juice—113 grams
Hamburger—227 grams	Tuna fish, drained—43 grams

Table 2. Radionuclide concentrations in Connecticut standard diet, January–June 1967 [a]

Month (1967)	Potassium (g/kg)	Strontium-90 (pCi/kg)	Cesium-137 (pCi/kg)
January	2.4	10	30
February	2.3	9	20
March	NS	NS	NS
April	2.3	10	30
May	2.2	8	10
June	2.1	11	20

[a] All strontium-89 values were <3 for this period.
NS, no sample collected.

Table 3. Daily radionuclide intakes in Connecticut standard diet, January–June 1967 [a]

Month (1967)	Potassium (g/day)	Strontium-90 (pCi/day)	Cesium-137 (pCi/day)
January	7.7	32	100
February	7.1	29	50
March	NS	NS	NS
April	7.1	31	90
May	6.7	25	40
June	6.8	33	60

[a] All strontium-89 values were <3 for this period.
NS, no sample collected.

strontium–90 and cesium–137 daily intakes are plotted as a function of time in figures 1 and 2.

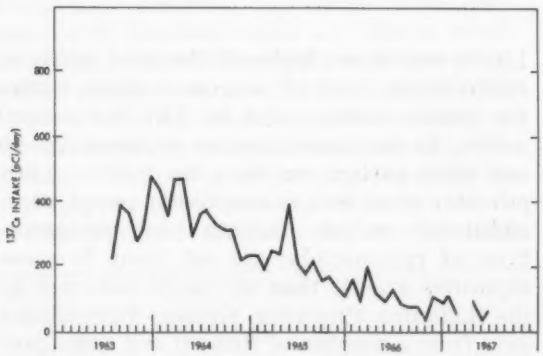

Figure 1. Cesium–137 intake in Connecticut standard diet 1963–June 1967

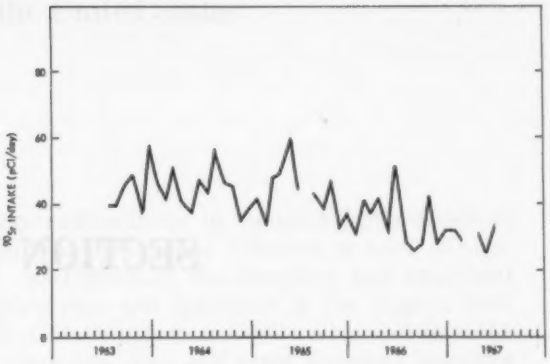

Figure 2. Strontium–90 intake in Connecticut standard diet, 1963–June 1967

REFERENCE

(1) CONNECTICUT STATE DEPARTMENT OF HEALTH. Estimated daily intake of radionuclides in Connecticut standard diet, March 1963–December 1964. Radiol. Health Data 6:381:382 (July 1965).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July 1965–June 1966	November 1966
July 1966–December 1967	May 1967

SECTION II. WATER

The Public Health Service, the Federal Water Pollution Control Administration, and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2-4*), set the limits for approval of a drinking water supply containing radium–226 and strontium–90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be set higher if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence of strontium–90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analyses indicate that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities recently reported in *Radiological Health Data and Reports* are listed below:

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium–90, respectively.

Activity	Period reported	Last presented
California Water Sampling Program	January–June 1966	June 1967
Minnesota Surface Water Sampling Program	July–December 1966	October 1967
New York Surface Water Sampling Program	January–December 1966	September 1967
Washington Surface Water Sampling Program	July 1965–June 1966	August 1967

REFERENCES

(1) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(2) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies. Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(3) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(4) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Gross Radioactivity in Surface Waters of the United States May 1967

Division of Pollution Surveillance, Federal Water Pollution Control Administration, Department of the Interior

The monitoring of levels of radioactivity in surface waters of the United States was begun in 1957 as part of the Federal Water Pollution Control Administration's Water Pollution Surveillance System. Table 1 presents the current preliminary results of the gross alpha- and beta-particle analysis. The radioactivity associated with dissolved solids provides a rough indication of the levels which would occur in treated water, since nearly all suspended matter is removed by treatment processes. Strontium–90 results are reported semiannually. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 indicates the average total beta radioactivity in suspended-plus-dissolved solids in raw water collected at each station. A description of the sampling and analytical procedures was published in the August 1967 issue of *Radiological Health Data and Reports.*

Complete data and exact sampling locations for 1958 through 1963 are published in annual compilations (*1-6*). Data for subsequent years are available on request.

Special note is taken when the alpha radioactivity is 15 pCi/liter or greater, or when the beta radioactivity is 150 pCi/liter or greater. These arbitrary levels provide a basis for the selection of data for additional comment.

They reflect no public health significance as

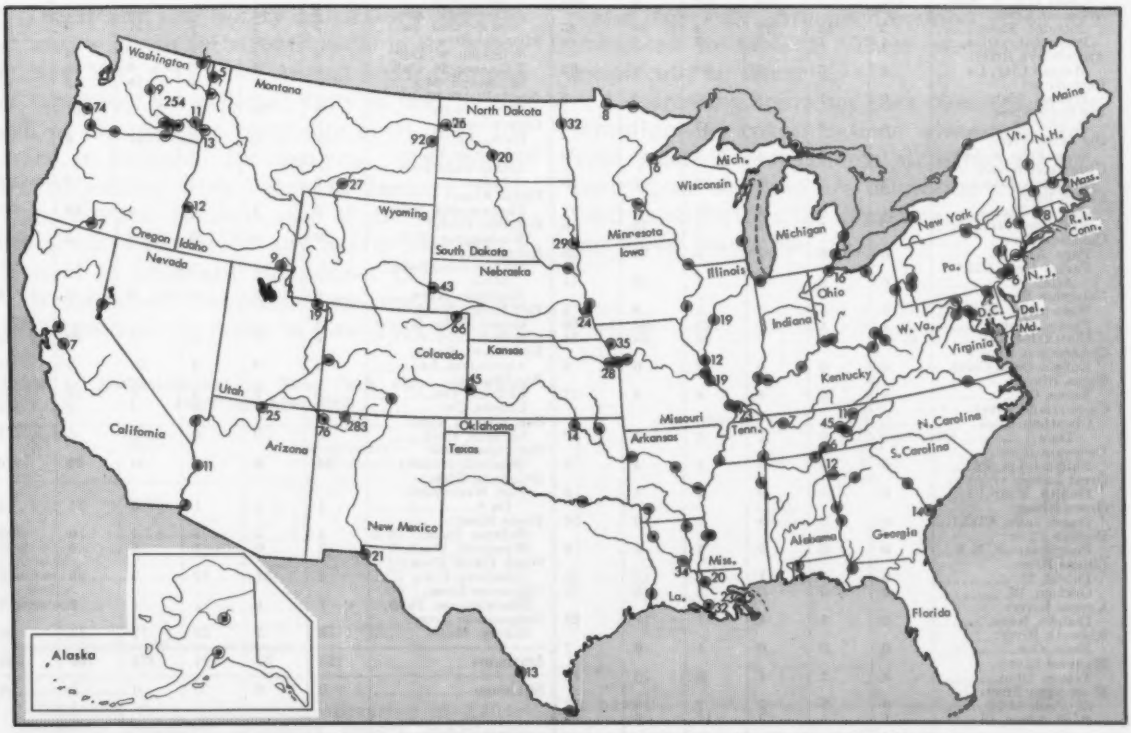

Figure 1. Sampling locations and associated total beta radioactivity (pCi/liter) in surface waters, May 1967

the Public Health Service drinking water standards have already provided the basis for this assessment. Changes from or toward these arbitrary levels are also noted in terms of changes in radioactivity per unit weight of solids. No discussion of gross radioactivity per gram of dissolved or suspended solids for all stations of the Water Pollution Surveillance System will be attempted at this time. Comments are made only on monthly average values. Occasional high values from single weekly samples may be absorbed into a relatively low average. When these high values are significant, comment will be made.

During both April and May, the following stations showed alpha radioactivity in excess of 15 pCi/liter on dissolved solids:

North Platte River; Henry, Nebr.
South Platte River; Julesburg, Colo.

In May, Coolidge, Kans., on the Arkansas River showed alpha radioactivity in excess of 15 pCi/liter on dissolved solids. Also, Sidney, Mont., on the Yellowstone River showed alpha radioactivity on suspended solids in excess of 15 pCi/liter.

Table 1. Radioactivity in raw surface waters, May 1967

Station	Average alpha radioactivity (pCi/liter)			Average beta radioactivity (pCi/liter)		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex.	123	1	124	278	5	283
Arkansas River:						
Coolidge, Kans.	2	16	18	9	36	45
Ponca City, Okla.	1	1	2	7	7	14
Atchafalaya River:						
Morgan City, La.	6	0	6	23	9	32
Bear River:						
Preston, Idaho	0	1	1	0	9	9
Big Horn River:						
Hardin, Mont.	4	7	11	13	14	27
Big Sioux River:						
Sioux Falls, S. Dak.	1	3	4	4	25	29
Clearwater River:						
Lewiston, Idaho	2	< 1	2	10	3	13
Clinch River:						
Clinton, Tenn.	1	0	1	8	3	11
Kingston, Tenn.[a]	0	1	1	< 1	45	45
Colorado River:						
Page, Ariz.	0	9	9	2	23	25
Parker Dam, Calif.-Ariz.	0	2	2	1	10	11
Columbia River:						
Wenatchee, Wash.	0	5	5	1	8	9
Pasco, Wash.[a]	< 1	1	1	126	182	308
Clatskanie, Ore.	< 1	1	1	22	52	74
Connecticut River:						
Enfield Dam, Conn.	0	0	0	2	6	8
Coosa River:						
Rome, Ga.	4	0	4	8	4	12
Cumberland River:						
Cheatham Lock, Tenn.	1	0	1	4	3	7
Delaware River:						
Philadelphia, Pa.	0	0	0	2	4	6
Great Lakes:						
Duluth, Minn.	0	0	0	2	4	6
Green River:						
Dutch John, Utah	0	3	3	1	18	19
Hudson River:						
Poughkeepsie, N.Y.	0	0	0	1	5	6
Illinois River:						
Peoria, Ill.	0	1	1	7	12	19
Grafton, Ill.	0	0	0	2	10	12
Kansas River:						
DeSoto, Kans.	2	2	4	11	17	28
Klamath River:						
Keno, Ore.	0	0	0	1	6	7
Maumee River:						
Toledo, Ohio	2	2	4	6	10	16
Mississippi River:						
St. Paul, Minn.	0	2	2	2	15	17
E. St. Louis, Ill.	1	1	2	11	8	19
Mississippi River—Continued						
New Roads, La.	2	1	3	13	7	20
New Orleans, La.	5	1	6	17	6	23
Missouri River:						
Williston, N. Dak.	3	2	5	12	14	26
Bismarck, N. Dak.	2	3	5	6	14	20
St. Joseph, Mo.	3	2	5	18	17	35
North Platte River:						
Henry, Nebr.	1	32	33	6	37	43
Ohio River:						
Cairo, Ill.	6	0	6	17	6	23
Pend Oreille River:						
Albeni Falls Dam, Idaho	0	< 1	< 1	1	4	5
Platte River:						
Plattsmouth, Nebr.	4	4	8	9	15	24
Potomac River:						
Washington, D.C.	0	0	0	2	5	7
Rainy River:						
International Falls, Minn.						
Baudette, Minn.	0	0	0	2	6	8
Red River, North:						
Grand Forks, N. Dak.	1	4	5	6	26	32
Red River, South:						
Alexandria, La.	9	0	9	29	5	34
Rio Grande:						
El Paso, Tex.	2	2	4	9	12	21
Laredo, Tex.	1	2	3	4	9	13
San Joaquin River:						
Vernalis, Calif.	0	0	0	2	5	7
San Juan River:						
Shiprock, N. Mex.	15	8	23	54	22	76
Savannah River:						
Port Wentworth, Ga.[a]	1	< 1	1	3	11	14
Snake River:						
Payette, Idaho	1	3	4	3	9	12
Wawawai, Wash.	1	0	1	6	5	11
South Platte River:						
Julesburg, Colo.	1	31	32	7	59	66
Tennessee River:						
Chattanooga, Tenn.	< 1	1	1	1	5	6
Yellowstone River:						
Sidney, Mont.	18	5	23	77	15	92
Maximum	123	32	124	278	182	308
Minimum	0	0	0	0	3	5

[a] Gross beta radioactivity at this station may not be directly comparable to gross beta radioactivity at other stations because of the possible contribution of radionuclides from an upstream nuclear facility in addition to the contribution from fallout and naturally occurring radionuclides.

Cedar Hill, N. Mex., on the Animas River had a very high suspended solids content in the sample collected on May 9. This high value yielded an average of more than 15 pCi/liter in alpha radioactivity, although the remaining sample values were well below 15 pCi/liter. Pasco, Wash., on the Columbia River continued to show beta radioactivity on dissolved solids in excess of 150 pCi/liter, and Cedar Hill, N. Mex., showed beta radioactivity on suspended solids in excess of 150 pCi/liter.

REFERENCES

(1) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. National water quality network annual compilation of data, PHS Publication No. 663, 1958 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(2) *Ibid.*, 1959 Edition.

(3) *Ibid.*, 1960 Edition.

(4) *Ibid.*, 1961 Edition.

(5) *Ibid.*, 1962 Edition.

(6) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. Water pollution surveillance system, annual compilation of data, PHS Publication No. 663 (Revised), 1963 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Radiostrontium in Tap Water, July-December 1966 [1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 in tap water at New York City since August 1954. Samples of tap water are collected daily so that by the end of the month a composite of at least 100 liters is available for analysis. Cesium–137 determinations were begun in January 1964. The analytical methods used at the laboratory are given in the Health and Safety Laboratory Manual of Standard Procedures (*1*).

Strontium–90 concentrations and cesium–137/strontium–90 ratios in New York City tap water for July through December 1966 are presented in table 1. These results appear graphically in figure 1.

A decreasing trend has been observed in the strontium–90 concentrations since the July 1963 peak. The maximum strontium–90 concentrations observed are below the acceptable limit as set forth in the interstate carrier drinking water standards (*2*).

Table 1. Radiostrontium in New York City tap water July–December 1966

Date	Strontium-90 [a] (pCi/liter)	Cesium-137/ strontium-90
1966		
July	0.92	0.24
August	.86	.21
September	.82	.12
October	.76	.09
November	.80	.14
December	.86	.07

[a] Approximately 100 liters per sample.

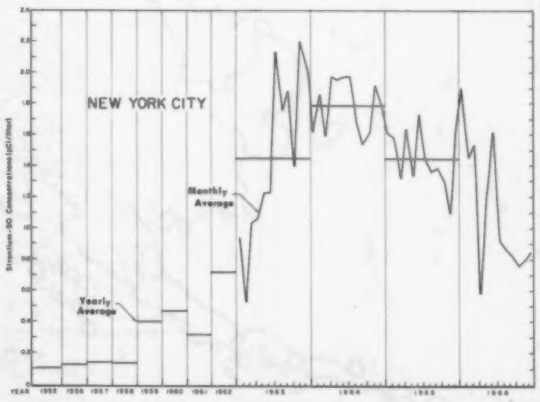

Figure 1. Strontium–90 concentrations in New York City tap water, 1955–December 1966

[1] Prepared from information appearing in Fallout Program Quarterly Summary Report, HASL–182. This report is available from the Clearinghouse for Federal Scientific and Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

REFERENCES

(1) U.S. ATOMIC ENERGY COMMISSION. Manual of standard procedures 40:E–38–01–16. Health and Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson Street, New York, N. Y.
(2) FEDERAL REGISTER RULES AND REGULATIONS. Title 42–Public Health, Chapter 1, Public Health Service, Department of Health, Education and Welfare; Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards 27:2154–5. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 6, 1962).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
May and July–November 1965	June 1966
November 1965–June 1966	December 1966

Radionuclides Analysis of Coast Guard Water Supplies January-December 1966

U.S. Coast Guard [1] and *National Center for Radiological Health* [2]

Beginning in October 1961, 1-gallon samples of water have been obtained from seven Coast Guard Loran Stations in Alaska (figure 1).

[1] U.S. Department of the Treasury.
[2] U.S. Public Health Service.

The prime source of potable water at the Adak Loran Station is Alpine Lake, which is at an elevation of 1,000 feet. The lake is occasionally frozen over with little snow cover each year from December through April. Water is

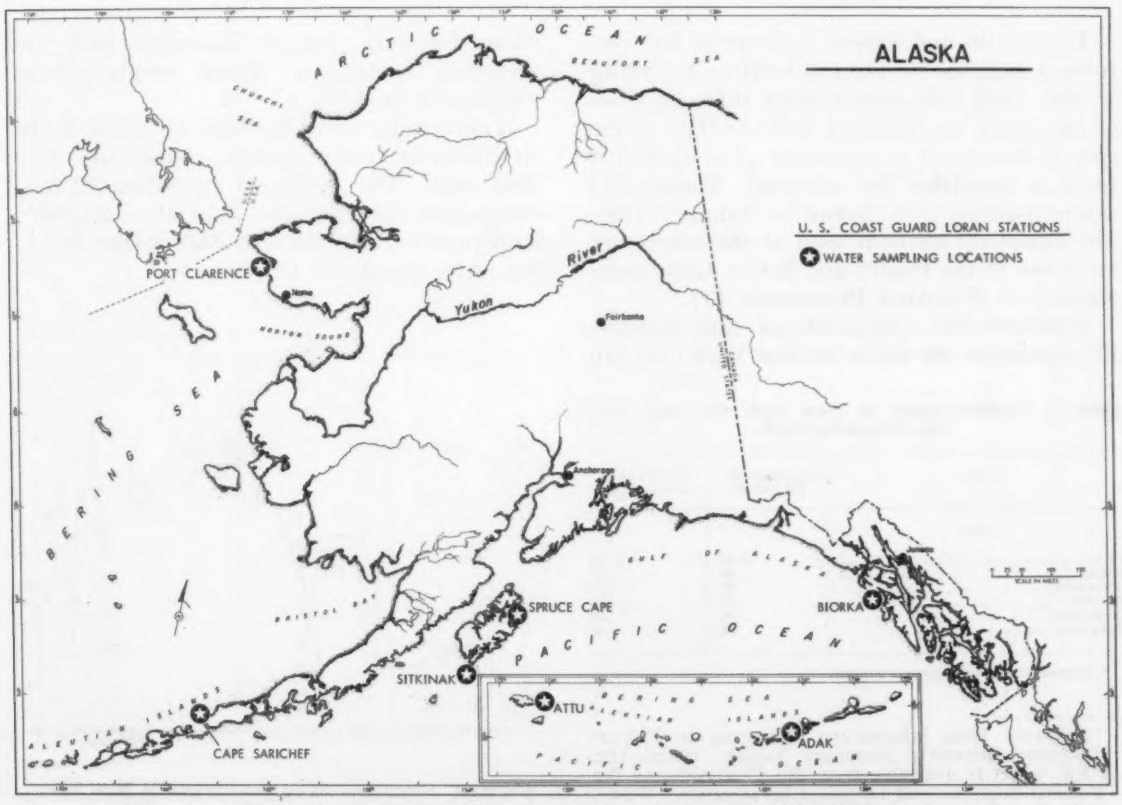

Figure 1. Coast Guard Loran station water sampling locations

delivered from the lake as needed through a 2-mile pipe line to three 25,000-gallon concrete reservoirs. All water is chlorinated at the station before use.

The Attu Loran Station's prime source of potable water is Alout Creek Dam and reservoir. This water source is usually frozen over from November through April, with a frequent snow cover of 1 to 3 feet. A 1-mile pipe line feeds water by gravity to three 25,000-gallon concrete reservoirs at the station. The water is chlorinated before use.

The Biorka Loran Station's water comes from a lake that is often frozen over lightly from January to March. The water is fed by gravity through a 1-mile-long insulated pipe to a pump house. From there it is pumped another mile to a 25,000-gallon steel storage tank from which it is fed by gravity one-half mile to the station, filtered, and chlorinated.

The source of water for the Cape Sarichef Loran Station is a small dammed creek and reservoir. The reservoir is usually frozen over from December through April, with 1 to 3 feet

Table 1. Radioactivity in water samples from U.S. Coast Guard Loran stations January–December 1966

Alaskan location	Collection date 1966	Gross alpha radioactivity (pCi/liter)	Gross beta radioactivity (pCi/liter)
Adak Island	January 14	1.0	8
	February 14	<0.1	6
	April 15	9.0	1
	May 11	< .1	6
	June 17	< .1	6
	September 12	.3	< 1
	October 12	< .1	< 1
	November 7	3.0	12
	December 6	< .1	1
Attu Island	January 7	.2	8
	February 3	< .1	6
	March 4	1.4	9
	March 31	.3	10
	April 29	< .1	2
	June 3	.5	< 1
	July 1	.5	< 1
	September 13	< .1	4
	October 11	< .1	< 1
	November 8	< .1	5
	December 6	< .1	6
Biorka Island	March 14	< .1	5
	May 31	4.5	5
	November 7	< .1	43
	December 6	< .1	18
Cape Sarichef	January 12	5.3	4
	February 12	.3	2
	March 5	< .1	4
	April 8	< .1	2
	April 11	.5	1
	May 10	1.0	5
	June 7	< .1	< 1
	July 6	< .1	5
	August 2	.7	< 1
	October 6	.7	4
	November 3	< .1	< 1
	December 5	< .1	4
Port Clarence	June 15	3.3	22
	September 15	< .1	16
	October 10	< .1	9
	November 9	< .1	11
	December 8	< .1	12
Sitkinak Island	January 15	.7	1
	February 16	.5	3
	March 11	.3	6
	April 18	< .1	5
	September 12	< .1	< 1
Spruce Cape	January 18	.3	1
	February 17	.2	< 1
	March 5	.2	1
	May 12	< .1	6
	June 10	< .1	3
	July 8	< .1	4
	September 12	.3	< 1
	November 3	< .1	5
	December 6	< .1	11
Maximum		9.0	43
Minimum		<0.1	< 1

of snow cover during that period. The water is pumped 1½ miles from the dam to a 25,000-gallon steel storage tank above ground, from which the water is fed by gravity to the station, filtered and chlorinated.

The Sitkinak Loran Station obtains its water from a natural lake which is normally frozen over from December through April, with 3 to 12 inches of snow cover during that period. The water is pumped from the lake through a 1,500-foot line to three 25,000-gallon concrete reservoirs at the Station. The water is filtered and chlorinated as used.

Port Clarence Loran Station's source of water is two shallow, flatland lakes, which freeze solid to their depth of 1½ to 3 feet from November through May. A variable snow cover of 1 to 5 feet is normal during this period. The water is pumped beneath the ice and seasonal frost to the station's concrete cisterns of 225,000-gallon capacity. Normally the entire capacity of the station's tanks is topped off prior to December 1 and only a small amount of water is pumped from the lake area after that date, depending on the thickness of snow, ice, and frost cover during the winter months. At the time of the first thaw, usually in May, the station tanks are again filled and kept filled until the following winter freeze. All water is filtered and chlorinated before use.

A natural hillside lake is Spruce Cape Loran Station's source of water. The lake is generally ice-free throughout the entire winter season with only light snowfall and general slush. The water is pumped one-half mile from the lake to a 25,000-gallon wood-stave cistern from which it is fed by gravity to the station, filtered, and chlorinated.

Water samples are analyzed for gross alpha and gross beta radioactivity, barium-lanthanum–140, cesium–137, iodine–131, ruthenium–103, ruthenium–106, and zirconium-niobium–95. The analyses for specific radionuclides are performed by gamma-ray spectrometry. All analyses are performed by the Southwestern Radiological Health Laboratory, Las Vegas, Nev. The results of the gross alpha and beta analyses are reported in table 1. Values for specific radionuclide content are not reported, since in all cases they were below the respective minimum detectable levels (cesium–137, 5 pCi/liter; all others, 10 pCi/liter).

Previous coverage in *Radiological Health Data and Reports:*

Period	Issue
January–December 1964	November 1965
January–December 1965	November 1966

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-particle analysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from the programs of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercomparison of the above programs was performed by Lockhart and Patterson in 1962 and is summarized in the January 1964 issue of *Radiological Health Data.* In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports:*

Network	Period	Issue
HASL Fallout Network	July–December 1966	September 1967
HASL 80th Meridian Network	Calendar Year 1965	January 1967

1. Radiation Surveillance Network July 1967

National Center for Radiological Health
U.S. Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Surveillance Network (RSN) which regularly collects samples from 74 stations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

Daily samples of airborne particulates and precipitation are forwarded to the Radiation Surveillance Network Laboratory in Rockville, Md., for laboratory analyses. The alerting function of the network is provided by routine field estimates of the gross beta radioactivity made by the station operators. These estimates are made after the decay of radon and thoron daughter products and prior to submission of the samples for laboratory analysis. When high air levels are reported, appropriate officials are promptly notified. Compilation of field estimates and laboratory confirmations are reported elsewhere on a monthly basis (*1*). A detailed description of the sampling and analysis procedures was presented in the November 1966 issue of *Radiological Health Data and Reports*.

Table 1 presents the monthly average gross beta radioactivity in surface air and deposition by precipitation during July 1967. Time profiles of gross beta radioactivity in air dating back to 1958 for eight RSN stations are shown in figure 2.

Radioactivity levels in airborne particulates remained near or below the detectability limit. The only precipitation sample more active than the 200 pCi/liter lower reporting limit was collected at Madison, Wisc., on July 31. This sample contained 5,100 pCi/liter gross beta radioactivity extrapolated to the time of collection and deposited 5.5 nCi/m^2. The sample was not typical of fresh nuclear testing debris in that it emitted no measurable gamma radiation.

Figure 1. Radiation Surveillance Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, July 1967

Station location		Number of samples		Air surveillance, gross beta radioactivity (pCi/m³)			Last profile in *RHD&R*	Precipitation	
		Air	Pptn	Maximum	Minimum	Average [a]		Total depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	31	9	0.06	0.01	0.03	Nov 67	215	<43
Alaska:	Adak	29	----	.05	.00	.01	June 67	[b]	
	Anchorage	23	9	.03	.00	.01	Dec 66	52	<11
	Attu Island	17	----	.01	.00	.00	July 67	[b]	
	Fairbanks	[c]	----	----	----	----	Jan 67	[b]	
	Juneau	21	17	.02	.00	.01	Apr 67	167	<33
	Kodiak	20	----	.02	.00	.01	May 67	[b]	
	Nome	9	----	.03	.00	.01	Sept 67	[b]	
	Pt. Barrow	29	----	.02	.00	.00	Aug 67	[b]	
	St. Paul Island	[c]	----	----	----	----	Oct 67	[b]	
Aris:	Phoenix	30	----	.09	.02	.04	Apr 67	[b]	
Ark:	Little Rock	27	7	.06	.02	.03	Dec 66	187	<37
Calif:	Berkeley	23	----	.04	.00	.02	May 67	[b]	
	Los Angeles	22	----	.04	.01	.02	Sept 67	[b]	
C.Z:	Ancon	19	----	.09	.00	.03	May 67	[b]	
Colo:	Denver	28	7	.18	.02	.06	May 67	102	<20
Conn:	Hartford	30	11	.03	.01	.02	Apr 67	80	<16
Del:	Dover	23	----	.05	.01	.03	Nov 67	[b]	
D.C:	Washington	30	11	.05	.01	.03	Aug 67	103	<21
Fla:	Jacksonville	31	11	.04	.01	.02	Dec 66	220	<44
	Miami	28	7	.09	.01	.03	Apr 67	120	<24
Ga:	Atlanta	31	10	.07	.02	.04	Oct 67	233	<47
Guam:	Agana	28	----	.46	.00	.06	Nov 67	[b]	
Hawaii:	Honolulu	31	1	.04	.00	.02	July 67	35	< 7
Idaho:	Boise	31	1	.12	.02	.05	July 67	2	< 1
Ill:	Springfield	31	11	.08	.02	.04	Aug 67	106	<21
Ind:	Indianapolis	31	7	.06	.02	.04	Oct 67	34	< 7
Iowa:	Iowa City	31	5	.09	.01	.05	May 67	95	<19
Kans:	Topeka	31	7	.07	.02	.04	Dec 66	102	<20
Ky:	Frankfort	28	14	.05	.02	.03	Aug 67	102	<20
La:	New Orleans	31	13	.06	.00	.03	Aug 67	181	<36
Maine:	Augusta	31	10	.04	.00	.02	Sept 67	98	<20
	Presque Isle	24	9	.08	.01	.03	May 67	47	< 9
Md:	Baltimore	23	5	.07	.02	.04	Apr 67	47	<10
	Rockville	14	----	.04	.01	.03	July 67	[b]	
Mass:	Lawrence	31	9	.06	.00	.03	Nov 67	74	<15
	Winchester	23	14	.06	.01	.03	June 67	68	<14
Mich:	Lansing	30	8	.06	.01	.03	July 67	34	< 7
Minn:	Minneapolis	19	5	.31	.01	.04	Nov 67	68	<14
Miss:	Jackson	30	10	.06	.01	.03	Sept 67	185	<37
Mo:	Jefferson City	31	8	.13	.01	.04	Oct 67	75	<15
Mont:	Helena	30	6	.12	.03	.06	June 67	12	< 2
Nebr:	Lincoln	20	5	.07	.02	.03	Oct 67	107	<22
Nev:	Las Vegas	31	----	.10	.02	.04	Jan 67	[b]	
N.H:	Concord	21	----	.06	.01	.03	Aug 67	[b]	
N.J:	Trenton	31	10	.05	.01	.02	Sept 67	59	<12
N. Mex:	Santa Fe	31	9	.14	.01	.04	June 67	37	< 7
N.Y:	Albany	21	6	.10	.02	.05	Oct 67	49	<10
	Buffalo	26	----	.07	.01	.03	May 67	[b]	
	New York	29	----	.06	.01	.02	June 67	[b]	
N.C:	Gastonia	31	9	.07	.01	.04	May 67	142	<29
N. Dak:	Bismarck	30	4	.06	.01	.04	Aug 67	14	< 3
Ohio:	Cincinnati	22	----	.05	.02	.03	Nov 67	[b]	
	Columbus	30	3	.09	.02	.05	Sept 67	45	< 9
	Painesville	31	9	.07	.01	.03	Apr 67	106	<21
Okla:	Oklahoma City	30	7	.06	.01	.03	July 67	25	< 5
	Ponca City	27	9	.03	.01	.01	Apr 67	152	<31
Ore:	Portland	31	----	.07	.01	.02	Oct 67	[b]	
Pa:	Harrisburg	31	1	.05	.00	.03	Oct 67	50	<10
P.R:	San Juan	22	9	.21	.02	.05	Sept 67	221	<44
R.I:	Providence	30	13	.04	.01	.02	July 67	116	<23
S.C:	Columbia	26	10	.04	.01	.03	June 67	80	<16
S. Dak:	Pierre	31	1	.06	.02	.04	Apr 67	10	< 2
Tenn:	Nashville	31	10	.05	.01	.03	July 67	186	<37
Tex:	Austin	31	1	.25	.02	.04	Nov 67	3	< 1
	El Paso	31	5	.08	.02	.04	Aug 67	67	<14
Utah:	Salt Lake City	31	4	.37	.01	.07	Sept 67	30	< 6
Vt:	Barre	31	11	.05	.02	.03	Dec 66	79	<16
Va:	Richmond	29	10	.04	.01	.03	Dec 66	42	< 9
Wash:	Seattle	31	----	.03	.00	.02	Dec 66	[b]	
	Spokane	31	----	.06	.02	.04	Nov 67	[b]	
W. Va:	Charleston	31	13	.06	.01	.03	June 67	122	<24
Wisc:	Madison	31	6	.13	.01	.03	Dec 66	60	<17
Wyo:	Cheyenne	30	6	.15	.02	.05	Jan 67	42	< 8
Network summary		1,980	413	0.46	0.00	0.03	----	90	<18

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.
[b] No precipitation sample collected.
[c] No report received.

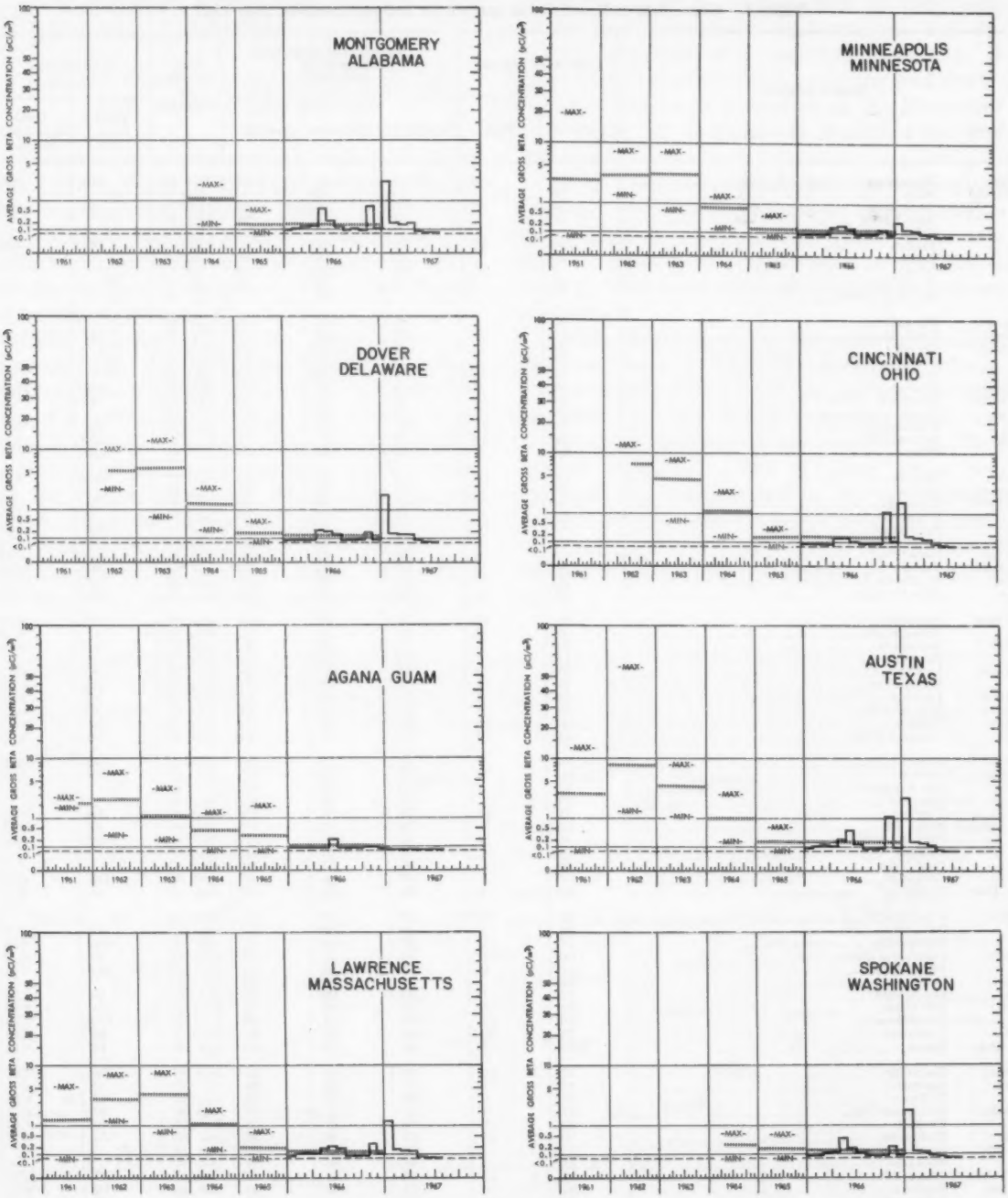

Figure 2. Monthly and yearly profiles of beta radioactivity in air—Radiation Surveillance Network, 1960–July 1967

2. Canadian Air and Precipitation Monitoring Program, July 1967

Radiation Protection Division, Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 3), where the sampling equipment is operated by personnel from the Meterological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*2-6*).

A summary of the sampling procedures and methods of analysis was presented in the November 1966 issue of *Radiological Health Data and Reports.*

[1] Prepared from information and data in the August 1967 monthly report "Data from Radiation Protection Program," Canadian Department of National Health and Welfare, Ottawa, Canada.

Surface air and precipitation data for July 1967 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, July 1967

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentrations (pCi/liter)	Total deposition (nCi/m²)
Calgary	31	0.1	0.0	0.0	57	0.4
Coral Harbour	28	.0	.0	.0	23	.8
Edmonton	31	.1	.0	.0	45	1.5
Ft. Churchill	31	.0	.0	.0	5	.4
Ft. William	31	.1	.0	.0	18	1.0
Fredericton	31	.0	.0	.0	18	1.3
Goose Bay	31	.0	.0	.0	9	1.1
Halifax	31	.0	.0	.0	8	1.1
Inuvik	31	.0	.0	.0	18	.6
Montreal	31	.1	.0	.0	14	1.0
Moosonee	31	.0	.0	.0	15	1.5
Ottawa	31	.0	.0	.0	10	1.5
Quebec	31	.0	.0	.0	11	1.9
Regina	31	.4	.0	.2	85	.4
Resolute	31	.0	.0	.0	6	.4
St. John's, Nfld.	31	.0	.0	.0	28	.9
Saskatoon	31	.0	.0	.0	43	.9
Saulte Ste. Marie	31	.1	.0	.0	26	1.1
Toronto	31	.1	.0	.0	18	1.3
Vancouver	31	.0	.0	.0	27	.6
Whitehorse	31	.0	.0	.0	12	.6
Windsor	31	.1	.0	.0	24	1.5
Winnipeg	31	.1	.0	.0	13	1.5
Yellowknife	31	.0	.0	.0	40	.6
Network summary	741	0.4	0.0	0.0	24	1.0

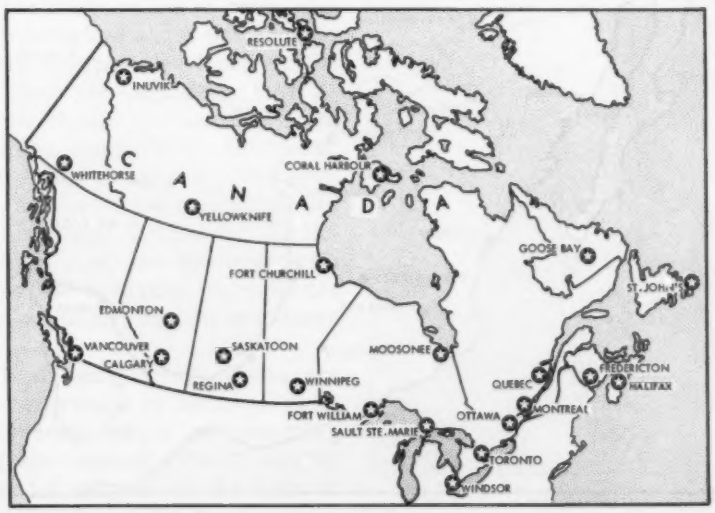

Figure 3. Canadian air and precipitation sampling stations

3. Mexican Air Monitoring Program July 1967

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), México, D.F. From 1952 to 1961, the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN.

In 1961, the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance Network. In 1966, the Division of Radiological Protection was restructured and its name changed to Dirección General de Seguridad Radiológica (DRS). The network consists of 16 stations (figure 4), 11 of which are located at airports and operated by airline personnel. The remaining five stations are located at México, D.F.; Mérida; Veracruz; San Luis Potisí; and Ensenada. Staff members of the DRS operate the station at México, D.F., while the other four stations are manned by members of the Centro de Previsión del Golfo de México, the Chemistry Department of the University of Mérida, the Institute de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

Sampling

The sampling procedure involves drawing air through a high-efficiency 6- by 9-inch glass-fiber filter for 20 hours a day, 3 or 4 days a week at the rate of 1,000 cubic meters per day using high-volume samplers.

After each 20-hour sampling period, the filter is removed and shipped via airmail to the Sección de Radioactividad Ambiental, CNEN, in México, D.F., for assay of gross beta radioactivity, allowing a minimum of 3 or 4 days after collection for the decay of radon and thoron. The data are not extrapolated to the time of collection. Statistically, it has been found that a minimum of eight samples per month were needed to get a reliable average radioactivity at each station (*7*).

The maximum, minimum, and average beta-particle concentrations detected in surface air during July 1967 are presented in table 4.

Figure 4. Fallout network sampling stations in Mexico

Table 4. Mexican gross beta radioactivity of airborne particulates, July 1967

Station	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Acapulco	3	0.1	0.1	0.1
Chihuahua	6	.1	.1	.1
Ciudad Juárez	1	< .1	< .1	< .1
Ensenada	6	.1	< .1	< .1
Guadalajara	NS			
Guaymas	NS			
La Paz	7	.1	< .1	< .1
Matamoros	NS			
Mazatlán	1	< .1	< .1	
Mérida	NS			
México, D. F.	4	.1	.1	.1
Nuevo Laredo	10	.1	.1	.1
San Luis Potosí	NS			
Tampico	13	.1	< .1	< .1
Torreón	9	.4	.1	.1
Veracruz	5	.1	< .1	< .1

NS, no sample collected, station temporarily shut down.

4. Pan American Air Sampling Program July 1967

Pan American Health Organization and *U.S. Public Health Service*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in the developing radiological health programs. The sampling equipment and analytical services are provided by the National Center for Radiological Health, PHS, and are identical with those employed for the Radiation Surveillance Network. The air sampling locations are shown in figure 5.

The July 1967 air monitoring results are given in table 5. Increases in airborne gross beta radioactivity occurred in all reporting stations south of the equator. Those samples more active than 1.0 pCi/m³ at the time of collection are presented in table 6.

Figure 5. Pan American Air Sampling Program stations

Table 5. PAHO gross beta radioactivity in surface air July 1967

Station location	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average [a]
Argentina: Buenos Aires	7	0.30	0.02	0.13
Bolivia: La Paz	18	29.01	.03	2.37
Chile: Santiago	31	2.52	.00	.30
Colombia: Bogota	20	.99	.00	.12
Ecuador: Guayaquil	26	9.21	.03	1.66
Jamaica: Kingston	21	.04	.01	.03
Peru: Lima	22	12.97	.04	2.37
Venezuela: Caracas	16	.24	.00	.04
West Indies: Trinidad	21	.25	.00	.04
Pan American summary	182	29.01	0.00	0.78

[a] The monthly average is calculated by weighting the individual samples with length of sampling period.

Table 6. Samples from PAHO member countries which contained radioactivity greater than 1 pCi/m³

Location	Date July 1967	Gross beta radioactivity at collection (pCi/m³)
Peru: Lima	13	3.18
	14	4.73
	15	4.40
	15–17	9.27
	18	12.97
	19	10.12
	20	5.06
	21	1.51
Chile: Santiago	15	1.11
	16	2.52
Ecuador: Guayaquil	15–17	9.21
	18	5.00
	19	7.25
	20	2.26
Bolivia: La Paz	4	29.01
	5	23.00
	13	2.97
	25	1.38

5. Plutonium in Airborne Particulates and Precipitation and Strontium–90 in Precipitation, April–June 1967

National Center for Radiological Health
U.S. Public Health Service

The Radiation Surveillance Network (RSN) of the National Center for Radiological Health, Public Health Service, located at Rockville, Md., performs analyses of airborne particulates and precipitation samples, collected at several geographically selected RSN stations, for total

Table 7. Plutonium in airborne particulates April–June 1967

Sampling location	Plutonium content [a] (pCi/1,000m³)		
	April	May	June
Alaska: Anchorage	0.032	0.048	0.029
Ariz: Phoenix	.159	.146	.057
Colo: Denver	.143	.076	.082
Hawaii: Honolulu	.067	.045	.047
Md: Rockville	.088	.087	.062
La: New Orleans	.137	.101	.037
N.Y: Buffalo	.082	.066	.091
N.C: Gastonia	.156	.096	.056
S. Dak: Pierre	.079	.077	.073
Tex: Austin	.101	.085	.094
Wash: Seattle	.040	.048	.036

[a] Plutonium includes ^{238}Pu, ^{239}Pu and ^{240}Pu.

Table 8. Plutonium and strontium-90 in precipitation, April–June 1967

	Station location							
	Denver	Honolulu	New Orleans	Rockville	Gastonia	Pierre	Austin	Seattle
Precipitation depth (mm)								
April	88.8	35.0	12.8	46.3	42.3	28.6	86.4	60.5
May	73.5	65.0	62.7	65.7	135.2	29.6	77.3	12.0
June	113.4	0.0	82.6	43.8	121.4	154.4	0.0	24.8
Total plutonium [a] (pCi/liter)								
April	0.054	0.031	0.025	0.030	0.011	[b]	.011	0.011
May	.029	.010	.018	.013	.013	[b]	.018	[b]
June	.012	[b]	.010	.021	.019	0.024	[b]	.013
Total plutonium [a] (pCi/m²)								
April	4.77	1.07	.33	1.38	.45	[b]	.93	.67
May	2.15	.68	1.01	1.17	1.72	[b]	1.42	[b]
June	1.38	[b]	.80	.92	2.32	3.62	[b]	.33
Strontium-90 (pCi/liter)								
April	6.70	3.15	.55	.55	4.06	[b]	1.20	1.72
May	3.70	.92	1.49	2.30	2.59	[b]	1.66	[b]
June	2.58	[b]	.67	.77	.87	1.57	[b]	1.08
Strontium-90 (pCi/m²)								
April	595.0	110.3	7.0	25.5	171.7	[b]	103.7	104.1
May	272.0	59.8	93.4	150.2	350.2	[b]	128.3	[b]
June	292.6	[b]	55.3	33.7	105.6	242.4	[b]	26.8

[a] Plutonium includes ^{238}Pu, ^{239}Pu and ^{240}Pu.
[b] Insufficient sample for analysis.

plutonium content and also analyzes the precipitation samples for strontium–90. The airborne particulate analyses were initiated in 1965. Details of collection, analysis, and results through March 1967 have been previously reported (*8-12*). Precipitation analysis began in August 1966 and the results thereof, together with the techniques employed were recently presented (*13*).

The results for April through June 1967 are presented in tables 7 and 8.

REFERENCES

(*1*) RADIATION SURVEILLANCE NETWORK. Monthly tabulation of findings. National Center for Radiological Health, Public Health Service, Rockville, Md. 20852 (Distribution by official request).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*3*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*4*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW–RP–5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*5*) BEALE, J., and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*6*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(*7*) VASQUEZ, M., and R. M. DE NULMAN. Estudios sobre la radioactividad ambiental en la República Mexicana, 1963–1965. Comisión Nacional de Energía Nuclear. Dirección General de Seguridad Radiológica. (in press 1966).

(*8*) RUSSELL, J., H. LEVINE, R. SCHNEIDER. Plutonium in airborne particulates, November 1965 through March 1966. Radiol Health Data Rep 7:483–484 (August 1966).

(*9*) DIVISION OF RADIOLOGICAL HEALTH. Plutonium in airborne particulates, April–June 1966. Radiol Health Data Rep 7:666–667 (November (1966).

(*10*) NATIONAL CENTER FOR RADIOLOGICAL HEALTH: Plutonium in airborne particulates, July–September 1966. Radiol Health Data Rep 8:108–109 (February 1967).

(*11*) NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Plutonium in airborne particulates, October–December 1966. Radiol Health Data Rep 8:288–289 (May 1967).

(*12*) NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Plutonium in airborne particulates, January–March 1967. Radiol Health Data Rep 8:534 (September 1967).

(*13*) LEVINE, H., W. P. KIRK, H. J. L. RECHEN. Plutonium and strontium–90 in precipitation, August 1966 through March 1967. Radiol Health Data Rep 8:574–576 (October 1967).

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in previous sections. Included are such data as those obtained from human bone sampling, bovine thyroid sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Strontium-90 in Human Vertebrae, 1966

Health and Safety Laboratory[1]
Atomic Energy Commission

One problem that concerns the Health and Safety Laboratory is the estimation of the radiation dose to man from fallout from nuclear weapons tests. To aid in the solution of this problem, several related studies have been undertaken by the laboratory. One of these is the systematic long-term determination of the strontium–90 content of human bone. Results of the strontium–90 analyses of foods have been published regularly and a summary of the data available through 1963 was given in an earlier report (*1*). A summary of the bone sampling program through 1964 together with an interpretation of the relationship between diet and bone levels was given in a previous publication (*2*). Summaries of the results of diet studies for 1964 and 1965 are found in reference (*3*). The results of the bone sampling program during 1965 have been presented elsewhere (*4*).

Results of the analyses of specimens obtained during 1966 are listed in tables 1 and 2 and are graphically shown in figure 1. As in previous years, vertebrae from New York City have about twice the strontium–90 concentrations found in vertebrae from San Francisco. In general, the distribution of strontium–90 concentrations with age is also similar to that observed in previous years, *i.e.*, the concentrations in bones from the younger children are greater than those in specimens from older individuals. More specifically, during 1965 and 1966 peak strontium–90 concentrations were observed in children of ages 1 to 2 and 2 to 3 at death while in previous years (1961–64) peak concentrations were found in children 0 to 1 year of age at death. This shift in peak concentrations to older children is to be expected when diet strontium–90 concentrations are declining as has been the case during 1965 and 1966. Fallout from the Chinese thermonuclear weapon detonated in June 1967 may be sufficient to just check the downward trend in diet strontium–90/calcium ratios and therefore this shift in peak strontium–90 bone levels to older ages may not be evident in samples obtained during late 1967 and early 1968.

[1] Material authored by Mr. J. Rivera, from Fallout Quarterly Summary Report, HASL–182, July 1, 1967. Available from the Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Va. 22151.

Table 1. Strontium-90/calcium ratios in human vertebrae New York City, 1966

Age	Strontium-90/calcium (pCi/g)	Number of specimens	Average
<1 mo.			
1 mo.–1 yr.	4.29 (6)[a]		
	4.42 (2)	8	4.32
1–2	7.04 (2)	2	7.04
2–3	5.98		
	6.36 (2)	3	6.23
3–4			
4–5	5.00	1	5.00
5–6	4.70 (2)	2	4.70
6–7	3.17		
	3.06		
	3.40	3	3.21
7–8	3.29		
	2.70		
	3.42		
	3.26	4	3.17
8–9	3.62		
	2.80	2	3.21
9–10	3.07	1	3.07
10–11	3.75	1	3.75
11–12			
12–13			
13–14			
14–15			
15–16	3.80	1	3.80
16–17	1.43		
	3.86		
	3.40	3	2.90
17–18	3.54	1	3.54
18–19	2.10	1	2.10
19–20			
20–40	2.62		
	2.03		
	1.33		
	1.96		
	2.81		
	1.89		
	2.70	7	2.19
40–60	1.89		
	1.90		
	2.79		
	1.59		
	1.60	5	1.95
>60	2.23		
	1.68		
	2.09		
	2.15		
	3.15		
	2.81		
	1.46		
	1.62		
	1.30		
	1.20	10	2.05

[a] Parentheses indicate number of individual samples in the composite.

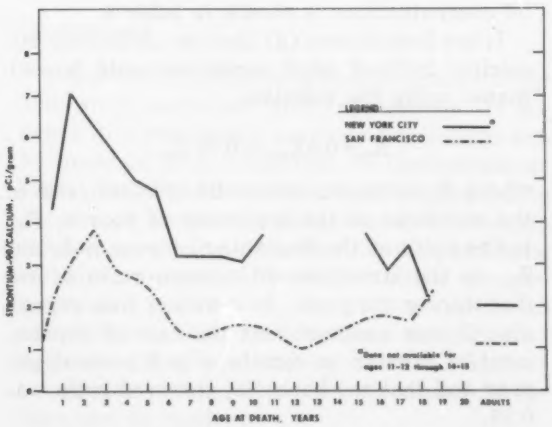

Figure 1. Strontium-90/calcium ratios in human vertebrae, 1966

Table 2. Strontium-90/calcium ratios in human vertebrae San Francisco, 1966

Age	Strontium-90/calcium (pCi/g)	Number of specimens	Average
<1 mo.	1.14 (4)[a]		
	1.27 (6)		
	1.22 (5)		
	0.98 (3)	18	1.18
1 mo.–1 yr.	2.59 (5)		
	2.13 (5)		
	3.29 (2)		
	1.34 (2)	14	2.35
1–2	2.27 (2)		
	3.87 (2)	4	3.07
2–3	3.81 (2)	2	3.81
3–4	1.95		
	2.81		
	3.78		
	3.16	4	2.93
4–5	2.93		
	3.42		
	1.83	3	2.73
5–6	2.20	1	2.20
6–7	1.46		
	1.31	2	1.38
7–8	1.71		
	0.90	2	1.31
8–9	1.46	1	1.46
9–10	1.58	1	1.58
10–11	1.46	1	1.46
11–12	0.95		
	1.46	2	1.21
12–13	0.98	1	0.98
13–14	1.77		
	2.81	2	2.29
14–15			
15–16			
16–17	1.79	1	1.79
17–18	1.70	1	1.70
18–19	2.35	1	2.35
19–20			
20–40	1.46		
	1.34		
	1.50	3	1.43
40–60	0.73		
	1.80	2	1.27
>60	.92		
	1.30		
	1.10		
	1.10	4	1.11

[a] Parentheses indicate number of individual samples in composite.

Quality control

The accuracy of the radiochemical analyses performed on samples obtained during 1966 may be judged from the quality control data in table 3. The precision of the analyses estimated from the quality control results for 12 blind duplicates is ±10 percent. The routine analyses of seven blank samples showed that there was no low-level contamination. All unknown samples analyzed had activities well above the routine minimum detectable radioactivity of from 0.1 to 0.2 disintegrations per minute per gram of ash, which corresponds to a strontium–90/calcium ratio of about 0.2 pCi/g calcium. The accuracy of the analyses as judged by the analyses of seven secondary standards was acceptable. Taking all factors into consideration the overall accuracy of a single analysis of a human bone specimen performed during 1966 is estimated to be about ±10 percent.

Table 3. Quality control samples—bone program, 1966 (dpm strontium-90/g ash)

Splits [a]	Blanks [b]	Standards [c]
2.0 ± .03 [d]	<0.05	5407 1.0 ±0.01 [d]
1.5 ± .01	.04± .01 [d]	5407 1.1 ± .01
1.0 ± .01	< .07	5407 1.1 ± .01
1.1 ± .01	.08± .04	5407 .73± .03
0.9 ± .01	.02± .01	5407 .98± .06
1.0 ± .01	< .06	B0126 12.5 ± .04
3.64± .03	< .11	B0126 16.7 ± .04
3.39± .03		
1.1 ± .01		
.9 ± .01		
3.07± .02		
3.17± .02		
2.28± .02		
1.96± .02		
.7 ± .01		
.8 ± .01		
1.5 ± .01		
1.4 ± .01		
1.35± .04		
1.39± .04		
3.16± .10		
2.88± .11		
2.74± .07		
3.06± .90		

[a] From these results the estimated standard deviation of a single measurement is ± 10 percent.
[b] Negative net count rates are reported as ≤ the counting error (1 standard deviation).
[c] Previous results obtained on these two samples were:
B0126—16.1 ±1.4 (46 analyses)
5407— 1.05±0.12(41 analyses)
[d] Counting error at 1 standard deviation.

Calculated and observed values

Although the accuracy of analyses is estimated to be within ±10 percent, the sampling errors are probably much greater. The average values listed in tables 1 and 2 for each age group are, however, probably valid for those groups where many specimens have been represented, *i.e.*, for the 0 to 1 year group and for adults.

The following formula for predicting the strontium–90/calcium ratios of infant bones was derived in an earlier report (*2*).

$$X = 0.2\ Z$$

where X is the average strontium–90/calcium ratio of infant bones during a year in which the diet had a strontium–90/calcium ratio of Z. In deriving the formula it was assumed that Z was not changing rapidly with time. An improvement in the formula is achieved by considering the strontium–90/calcium ratio of an infant at birth in January to be one-tenth the strontium–90/calcium ratio of the diet for October, November, and December (assuming the mother's diet during the last trimester of pregnancy was not different from that of the general population). The strontium–90/calcium ratio of an infant at the end of the first year of life is assumed to be given by the equation (*2*):

$$X_1 = \frac{30(X_o) - 30(X_o)(f) + 30(f)(K)(Z) + 70(K)(Z)}{100}$$

where, X_o = the strontium–90/calcium ratio at birth, f is the fractional replacement of calcium during the year, K is the bone-diet observed ratio, Z is the strontium–90/calcium ratio of the child's diet during the year (assumed here to be the same as the general diet) and the calcium content of the skeleton is assumed to increase from 30 grams at birth to 100 grams at 1 year of age.

Taking $X_o = 0.10\ Z_m$, where Z_m is the average strontium–90/calcium ratio of the diet for October, November and December of the preceding year, f = 0.50 and K = 0.35, the average strontium–90/calcium ratio of infant bones during the first year of life should be given by:

$$\bar{X}_{0-1} = \frac{X_o + X_1}{2} = \frac{0.10\ Z_m + 0.03\ Z_m + 0.30\ Z}{2}$$

$$\bar{X}_{0-1} = 0.065\ Z_m + 0.15\ Z$$

A comparison of calculated and observed values obtained using this relation and data obtained since 1962 on diet and bone strontium–90 concentrations is shown in table 4.

It has been shown (*2*) that the strontium–90/calcium ratio of adult vertebrae could be estimated using the relation:

$$X_n = 0.9X_{n-1} + 0.02\ Z_{n-1}$$

where X_n is the strontium–90/calcium ratio of the vertebrae at the beginning of year n, X_{n-1} is the ratio at the beginning of year n–1, and Z_{n-1} is the strontium–90/calcium ratio of the diet during the year. In deriving this expression it was assumed that the rate of replacement of calcium in vertebrae is 8 percent per year and that the bone-diet observed ratio was 0.25.

Since the observed adult strontium–90/calcium ratios used in calculations are average

Table 4. Calculated and observed strontium-90/calcium ratios in infant bone during the first year of life

Year	New York City				San Francisco			
	Z	Z_m	$\bar{X}_{a-1}$		Z	Z_m	$\bar{X}_{a-1}$	
			Calculated	Observed			Calculated	Observed
1962	13	10	2.6	4.1	5	4	1.1	1.2
1963	31	18	5.8	7.6	10	7	2.0	2.5
1964	32	35	7.1	7.9	14	14	3.0	2.9
1965	24	29	5.5	5.0	12	10	2.5	3.3
1966	19	22	4.3	4.3	6	9	1.5	2.4

Table 5. Calculated and observed strontium-90/calcium ratios in adult bone

Year	New York City			San Francisco		
	Z_{n-1}	X_n		Z_{n-1}	X_n	
		Calculated	Observed		Calculated	Observed
1961			0.89			0.52
1962	10.5	1.01	1.03	4.1	0.55	.74
1963	21.3	1.36	1.55	8.2	.83	.98
1964	34.4	2.06	2.02	14.8	1.18	1.23
1965	16.3	2.14	2.13	12.3	1.36	1.16
1966	22.0	2.35	2.06	9.1	1.22	1.25

values rather than values at the beginning of calendar years, the appropriate value of Z that should be used in the above equation is the average value for the interval from midyear to midyear. A comparison of calculated with observed strontium–90/calcium ratios in adult bone using this formula and the appropriate diet values, taken from a graph of the results of the tri-city diet studies, is shown in table 5.

Conclusions

Results of the bone sampling program during 1966 were consistent with expectations. It appears that reasonably accurate predictions can be made of bone strontium–90 concentrations from diet strontium–90 concentrations. The agreement between predictions and observations supports the view that the diet and bone sampling programs in the two cities are representative. Moreover, the proportionality in bone levels to diet concentrations suggests that bone concentrations may be inferred wherever reasonable estimates of diet strontium–90 intake can be made.

Constructing models to predict strontium–90 concentrations in bones of children from 1 to 19 years of age from survey diet and bone data is very difficult because of the few samples obtainable in any given year. It is hoped that the meager data available each year may somehow be combined and that a model may then be developed that is as good as that for infants and adults now in existence.

REFERENCES

(*1*) RIVERA, J. and J. H. HARLEY. HASL contributions to the study of fallout in food chains. Atomic Energy Commission Report, HASL–147 (July 1, 1964).
(*2*) RIVERA, J. and J. H. HARLEY. The HASL bone program, 1961–1964. Atomic Energy Commission Report No. HASL–163 (August 16, 1965).
(*3*) RIVERA, J. Strontium–90 in the diet: Verification of predictions for 1964 and 1965 and predictions for 1966 and 1967. Atomic Energy Commission Report No. HASL–173 (October 1, 1966).
(*4*) RIVERA, J. Strontium–90 in human vertebrae–1965 results. Atomic Energy Commission Report No. HASL–172 (July 1, 1966).

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U. S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the AEC Manual. [1]

Summaries of the environmental radioactivity data follow for the Lawrence Radiation Laboratory and the Mound Laboratory.

[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Lawrence Radiation Laboratory July–December 1966 [2]

University of California
Berkeley, California

The Berkeley site of the Lawrence Radiation Laboratory (LRL) is located to the east of the University of California campus (figure 1). Winds are generally westerly; annual rainfall is 23 inches, most of which usually falls during the period from November through April. Technical facilities include a 6.3 BeV proton accelerator (Bevatron), a 700–MeV cyclotron, a 10–MeV linear accelerator, an 88-inch cyclotron, and associated chemistry and physics laboratories.

The environmental monitoring program includes sampling for radionuclides in the atmosphere, surface and ground waters, sewage, rain, and dry depositions.

Three types of atmospheric samples are taken: laboratory exhaust duct samples, local area samples and perimeter samples. One hundred and twelve exhaust air ducts with potential for releasing radioactive contaminants are sampled continuously at a flow rate of 2 liters/minute. The 1-inch diameter filters are changed weekly and counted for beta radioactivity by an end-window Geiger-Mueller tube and for alpha radioactivity by a thin-window proportional counter. Continuous local area and perimeter air samples are taken at scattered locations on the laboratory site and at the property line, respectively. The samples are obtained on 4- by 9-inch HV–70 filter papers at 4 cubic feet per minute. The filters are collected weekly and counted for alpha radioactivity by a thin-window proportional counter and for beta radioactivity by a 30 mg/cm^2-window Geiger-Mueller tube. The levels of radioactivity observed in each type of sample are presented in table 1.

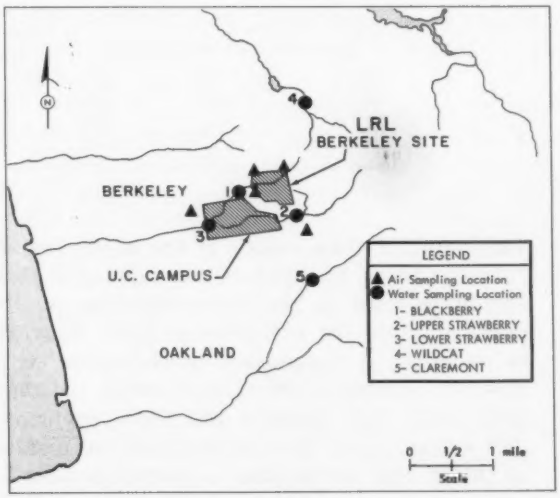

Figure 1. Environmental sampling locations at the Berkeley site

[2] Summarized from "Results of Environmental Radioactivity Sampling Program, July–December 1966," Lawrence Radiation Laboratory, Livermore and Berkeley, Calif.

Table 1. Atmospheric monitoring, LRL Berkeley site July–December 1966

Sampling location (number of locations)	Number of samples	Concentration [a] (pCi/m³)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum	Average	Maximum
Exhaust ducts (112)	4,678	<0.07	[b]	<1.6	[b]
Local area (9)	235	< .005	<0.005	< .15	1.7
Perimeter (4)	104	< .005	0.005	< .15	2.3

[a] Limits of detectability for individual samples (pCi/m³)
Exhaust ducts ..... 0.07 alpha 1.6 beta
Local area and perimeter ..... 0.005 alpha 0.15 beta
[b] No reported data.

Rain and dry deposition samples are collected monthly in 18-inch diameter cylindrical vessels lined with polyethylene bags at local area and perimeter sites. Precipitation samples are concentrated by evaporation. Dry samples are removed from the collection vessel with a dilute nitric acid rinse and then concentrated by evaporation. Final evaporation is effected in 2-inch diameter stainless-steel planchets, which are flamed and coated with a thin lacquer film. The planchets are counted for alpha radioactivity in an internal-flow proportional counter and for beta radioactivity with a thin-window, low-background Geiger-Mueller flow counter. No correction ismade for self-absorption in the sample. Deposition data are given in table 2.

Table 2, Total deposition, LRL Berkeley site July–December 1966

Sampling location (number of locations)	Number of samples	Deposition (nCi/m²)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum [a]	Average	Maximum [a]
Local area (10)	52	0.08	0.19	4.82	5.60
Perimeter (4)	23	.12	.18	4.90	6.68

[a] Maximum deposition at a single location for the 6-month period.

Water samples are taken from sewers, onsite streams, and offsite streams. Two sewer lines serve the LRL area. The "Hearst" sewer receives waste from the larger part of the area. A sampling system takes a continuous proportional sample from the Hearst sewer as it leaves the laboratory boundary. Samples are also taken of waste feeding into the Hearst sewer from buildings 70, 70A, and 71. The "Strawberry" sewer receives waste from the southeast part of the laboratory site. A monitoring station takes a continuous proportional sample from this sewer. Continuous samples are also taken from the acid waste systems in building 74. The concentrations of radioactive wastes in sewage, shown in table 3, are either those observed directly in samples from the sewer line or those calculated from samples taken from contributing waste streams, whichever is the higher value. Strawberry and Blackberry Creeks comprise the laboratory's storm drainage. These are sampled weekly at three locations. Two other nearby offsite streams are also sampled weekly. All water samples are handled in the same manner as rain samples. The results from the water sampling program are presented in table 3.

Table 3. Water monitoring, LRL Berkeley site July–December 1966

Type and source of sample	Number of samples	Concentration (pCi/liter)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum	Average	Maximum
Sewage:					
Hearst sewer	25	0.30	1.1	28	106
Strawberry sewer	26	.58	3.6	59	362
Tap water	26	.09	.4	2.2	4.2
Surface water:					
Onsite streams	81	1.03	13.3	7.4	36.3
Offsite streams	53	.71	10.0	2.6	9.3

Livermore site

The Livermore site of LRL (figure 2) is located about 50 miles southeast of San Francisco, Calif. Annual precipitation in the Livermore Valley is about 14 inches; prevailing winds are from the west with frequent nocturnal inversions. Technical facilities include a small cyclotron, a 2-megawatt swimming pool reactor, and physics and chemistry programs associated with a weapons development program.

An environmental sampling program is maintained to provide information regarding the effectiveness of control measures and to determine whether any radiological changes in

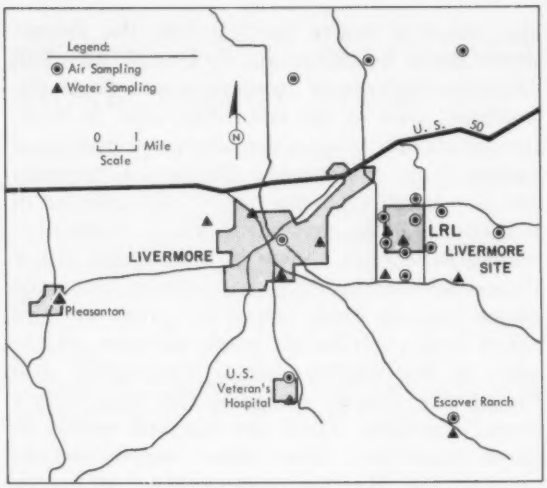

Figure 2. Environmental sampling locations at the Livermore site

the environment are the result of laboratory operations. The sampling program includes air particulates, soil, domestic water, sewer effluent, sewage plant products, milk, and vegetation. The milk samples are obtained from two dairies in the Livermore Valley and one in another valley about 25 miles away, which is used as a check. Air samples are collected to ascertain that control efforts are restricting the release of radioactivity from the laboratory to levels which do not exceed the permissible levels for the neighborhood around an atomic energy facility. The water samples are collected to monitor radioactivity in an underground water supply which provides most of the domestic water for the cities of Livermore and Pleasanton, and is the sole supply for ranches in the Livermore and Amador Valleys.

Air samples are collected continuously at 15 sites within 5 miles of the laboratory. Samples are collected at a rate of 4 cfm on 100-square centimeter HV–70 filter papers, which are changed after every 7 days of operation. A minimum decay period of 96 hours is observed before the samples are counted to eliminate the effect of natural radon and thoron daughters. All environmental air samples are counted in an automated system which utilizes gas-flow proportional detectors for both alpha and beta radioactivity measurements. Alpha radioactivity in 412 air samples collected from 15 sampling locations averaged 0.0010 pCi/m^3, while beta radioactivity averaged 0.051 pCi/m^3. The applicable AEC radiation protection standards are 0.040 pCi/m^3 for alpha-particle emitters and 1 pCi/m^3 for beta-particle emitters.

The measurement of low level "background" radiation during this period was accomplished with fluoroglass dosimeters located at nine points on the site perimeter and at two nearby ranches. Due to equipment failure, the data for the second half of 1966 are not available at this time.

Domestic water samples are collected monthly from nine nearby sources. No water sample showed alpha radioactivity above the limit of sensitivity (5.0 pCi/liter) for the automatic gas-flow proportional detection system. The beta radioactivity ranged from less than the limit of sensitivity (1.8 pCi/liter) to 11 pCi/liter. The average alpha and beta radioactivity in water samples was less than their respective AEC radiation protection standards of 10 and 100 pCi/liter.

Samples are collected every Monday, Wednesday, and Friday, at the sewer line leaving the southwest project boundary, where it connects with the Livermore domestic sewerage system. Grab samples are collected monthly at the Livermore Sewage Disposal Plant to assure that the liquid effluent from the laboratory is not creating abnormal radioactivity concentrations either in the oxidation ponds (which overflow into a natural waterway) or in the dried sludge (which is used as an agricultural soil conditioner). Radioactivity levels in the raw sewage, oxidation ponds, and dried sludge are summarized in table 4.

Table 4. Environmental sampling, LRL Livermore site July–December 1966

Type of sample (concentration units)	Average aloha radioactivity	Average beta radioactivity
Raw sewage (pCi/liter)	9	42
Oxidation ponds (pCi/liter)	5	25
Dried sludge (pCi/g)	17	20

Samples of top layer soil are collected quarterly at the 19 sampling stations surrounding the Livermore site. The alpha radioactivity fluctuated from less than the limit of sensitivity (1.5 pCi/g) to 9 pCi/g. The beta radioactivity fluctuated from less than the limit of sensitivity

(3.5 pCi/g) to a single sample high of 128 pCi/g following the third Chinese nuclear test in May. All other samples were below 35 pCi/g. The average alpha radioactivity was 3.0 pCi/g and the average beta radioactivity was 14.2 pCi/g. The concentrations detected are within the normal range for soil in the Livermore Valley.

Average radioactivity levels in monthly milk samples amounted to 4 pCi/liter of cesium–137 and 2 pCi/liter of cerium–141–144, for the two Livermore dairies. These levels closely correspond to those for a dairy in a neighboring valley about 25 miles from Livermore.

Site 300

Site 300 (figure 3) is located in a very sparsely populated ranching area about 17 miles southeast of the Lawrence Radiation Laboratory at Livermore. Air and water samples are taken to determine whether operations at Site 300 are changing the normal radioactivity levels in the vicinity. The eight air samplers at Site 300 are operated at about 50 cfm on a continuous basis with the filter papers being changed on regular schedule. Most of these air samplers are located within the boundaries of the test site due to unavailability of power facilities offsite. Water samples are taken from six onsite wells because they are the only readily accessible sources of underground water. Samples are collected from streams only during the winter months when water flow exists. Soil samples are collected quarterly at nine offsite locations. Only top layer soil is collected to determine fallout concentrations. All air, water, and soil samples are processed at the laboratory in Livermore. The average radioactivity levels in samples collected are summarized in table 5.

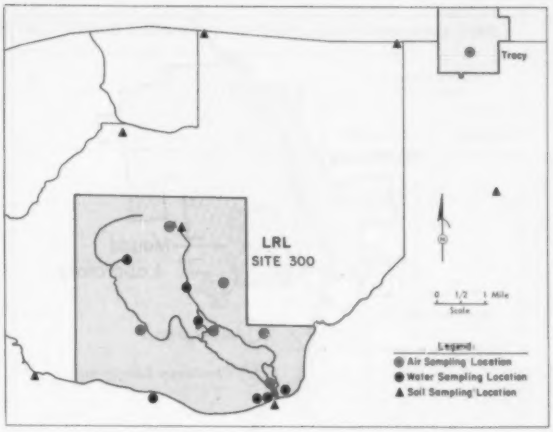

Figure 3. Sampling locations at Site 300 Lawrence Radiation Laboratory

Table 5. Environmental sampling, LRL Site 300 July–December 1966

Type of sample (concentration units)	Average alpha radioactivity	Average beta radioactivity
Air (pCi/m³)	0.0005	0.055
Water (pCi/liter)	<5	4.3
Soil (pCi/g)	6	11

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1965	November 1966
January–June 1966	June 1967

2. Mound Laboratory, July–December 1966 and annual summary 1966 [3]

Monsanto Research Corporation
Miamisburg, Ohio

The environmental monitoring program for Mound Laboratory is planned and coordinated with all of the projects conducted at the laboratory. Air and water monitoring in the uncontrolled environs surrounding the laboratory is specific for the radionuclides which could be released to the environment. Only polonium–210, plutonium–239, and hydrogen–3 (tritium) are potential environmental contaminants.

Air monitoring

Mobile air monitoring equipment, mounted on a 1-ton panel truck, for measurement of

[3] Summarized from "Environmental Monitoring Report: July–December 1966 and 1966 summary," MLM–1391.

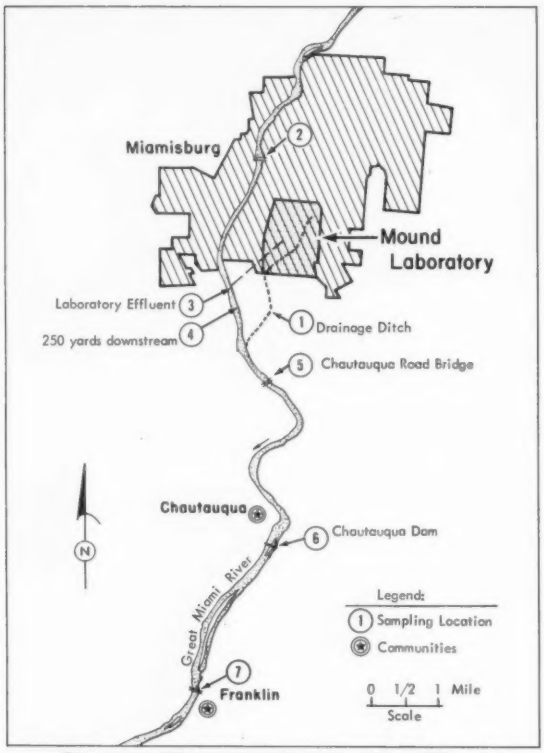

Figure 4. Water sampling locations, Mound Laboratory

tritium and collection of particulate alpha-particle emitters was used in the routine monitoring of environmental air in a network of 111 locations within a radius of 20 miles from the laboratory during the collection period. The choice of sites on a given day was dependent upon the wind direction at the time of collection.

During the 6-month period ending December 1966, weekly samples were collected and analyzed for airborne tritium. In all cases, tritium was not detectable in offsite environmental air samples.

A total of 366 air samples were collected and analyzed for possible polonium and plutonium contaminants in the environment. A long-lived gross alpha radioactivity determination was made on filter-paper samples after a sufficient time had elapsed to permit the decay of the short-lived daughter products of radon and thoron. The filter-paper samples were counted for alpha-particle emissions in a low-background proportional counter. The average measured concentrations of alpha radioactivity in air are summarized in table 6. No specific determinations of polonium–210 or plutonium–239 were made, since the gross alpha radioactivity remained substantially below the environmental limits for these nuclides.

Table 6. Atmospheric monitoring of long-lived alpha radioactivity, Mound Laboratory environs, July–December 1966

Sampling location	Number of samples	Concentration (pCi/m³)	
		Maximum [a]	Average [b]
Upwind from laboratory	52	0.0168	0.0041
Downwind from laboratory	314	.5542	.0724

[a] The minimum detectable concentration for long-lived alpha radioactivity concentrations in air is 0.0035 pCi/m³. All values which were not detectable were set equal to this value when average values were calculated.

[b] The applicable AEC radiation protection standards for uncontrolled areas are as follows:
Polonium-210 in air: 20 pCi/m³
Plutonium-239 in air: 0.06 pCi/m³

Water monitoring

Liquid radioactive waste materials from polonium and plutonium operations at the laboratory are processed in special waste disposal plants designed to reduce radioactivity to a concentration at which it may be discharged to the Great Miami River.

Helium–3, which is purified at the Mound Laboratory, contains small quantities of tritium. Liquid wastes from this operation are treated separately to assure that the radioactivity level is below the AEC radiation protection standard before discharge to the Great Miami River.

Weekly water samples are collected from a drainage ditch and six locations along the Great Miami River as shown in figure 4. Additional samples are taken quarterly at more distant downstream points. The drainage ditch carries all storm sewer water and treated liquid tritium and plutonium wastes from the plant site. Sampling location number 3 (figure 4) is the point of discharge of the liquid polonium waste to the Great Miami River, and number 7, at Franklin, Ohio, is 5 miles downstream from the effluent outfall.

All of the river samples are analyzed for polonium–210. The drainage ditch samples and

Table 7. Offsite water monitoring for radioactivity, Mound Laboratory environs, July–December 1966

Nuclide and sampling location [a]	Number of samples	Concentration (pCi/liter)	
		Maximum	Average [b]
Polonium-210 [c]			
2 (Upstream from laboratory)	24	2.7	1.8
3 (Laboratory effluent)	24	1,792.8	121.2
4 (250-yards downstream)	24	3.6	1.9
5 (Chautauqua Road Bridge)	24	2.7	1.8
6 (Chautauqua Dam)	23	1.8	1.8
7 (Franklin, Ohio)	24	3.6	1.8
Trenton, Ohio	2	1.8	1.8
New Miami, Ohio	2	1.8	1.8
7 miles upstream from New Baltimore, Ohio	2	1.8	1.8
New Baltimore, Ohio	2	1.8	1.8
Elizabethtown, Ohio	2	1.8	1.8
Hydrogen-3 (tritium) [d]			
1 (Drainage ditch)	24	0.43×10^6	0.10×10^6
2 (Upstream from laboratory)	24	$.11 \times 10^6$	$.05 \times 10^6$
3 (Laboratory effluent)	24	$.58 \times 10^6$	$.14 \times 10^6$
5 (Chautauqua Road Bridge)	24	$.14 \times 10^6$	$.06 \times 10^6$
Plutonium-239 [e]			
1 (Drainage ditch)	22	14.2×10^2	1.1×10^2

[a] See figure 4 for number of sampling locations.
[b] The applicable AEC radiation protection standards for uncontrolled area are as follows:
Polonium-210 in water: 7×10^2 pCi/liter
Plutonium-239 in water: 5×10^2 pCi/liter
Hydrogen-3 in water: 3×10^6 pCi/liter
[c] Minimum detectable level for polonium-210 in water is 1.80 pCi/liter.
[d] Minimum detectable level for hydrogen-3 in water is 0.05×10^6 pCi/liter.
[e] Minimum detectable level for plutonium-239 in water is 0.09 pCi/liter.

some of the river samples are analyzed for tritium. The drainage ditch samples are also analyzed for plutonium–239. Average concentrations of tritium, polonium–210, and plutonium–239 are given in table 7 for July–December 1966.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1965	November 1966
January–June 1966	May 1967

Reported Nuclear Detonation, October 1967

The U. S. Atomic Energy Commission announced two underground nuclear tests conducted at its Nevada Test Site during October 1967. On October 18, 1967 a nuclear test of intermediate yield (200 kilotons to 1 megaton TNT equivalent) was conducted underground. On October 25, an underground test of low yield (less than 20 kilotons TNT equivalent) was conducted at the Nevada Test Site.

On October 17, 1967, the Atomic Energy Commission announced that the United States had recorded seismic signals which originated from the Soviet nuclear test area in the Semipalatinsk region. The signals were equivalent to those of a nuclear test in the low-intermediate yield range (20 to 200 kilotons TNT equivalent).

On October 23, 1967, the AEC announced that the United States had recorded seismic signals which originated from the Soviet nuclear test area in the Novaya Zemlya region. The signals were equivalent to those of a nuclear test in the lower end of the intermediate range (200 kilotons to 1 megaton TNT equivalent).

SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

STATE HEALTH DEPARTMENT SAMPLING CRITERIA FOR SURVEILLANCE OF RADIOACTIVITY IN MILK. *R. H. Neill and D. R. Snavely. Radiological Health Data and Reports, Vol. 8, November 1967, pp. 621–627.*

This report summarizes criteria used by the States in setting up their milk sampling programs for measurement of radioactivity and the sample typing, collection points, and measurements used. Also included are the times required by the States from sample collection to the final radioactivity concentrations of the various radioisotopes found in milk.

KEY WORDS: Cesium–137, geography, iodine–131, milk surveillance, nuclear facilities, pasteurized milk, population, production and processing, raw milk, State Health departments, strontium–89, strontium–90.

Erratum

In the September 1967 issue of Radiological Health Data and Reports, the footnote to the report "Radioactivity in the Mexican Environment," on page 495, should have read as follows:

"Mr. Vasquez Barete is Director General of Radiological Safety and Mrs. Nulman is physicist, Comision Nacional de Energia Nuclear, Mexico, D.F."

The editors regret the error.

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November 1967

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